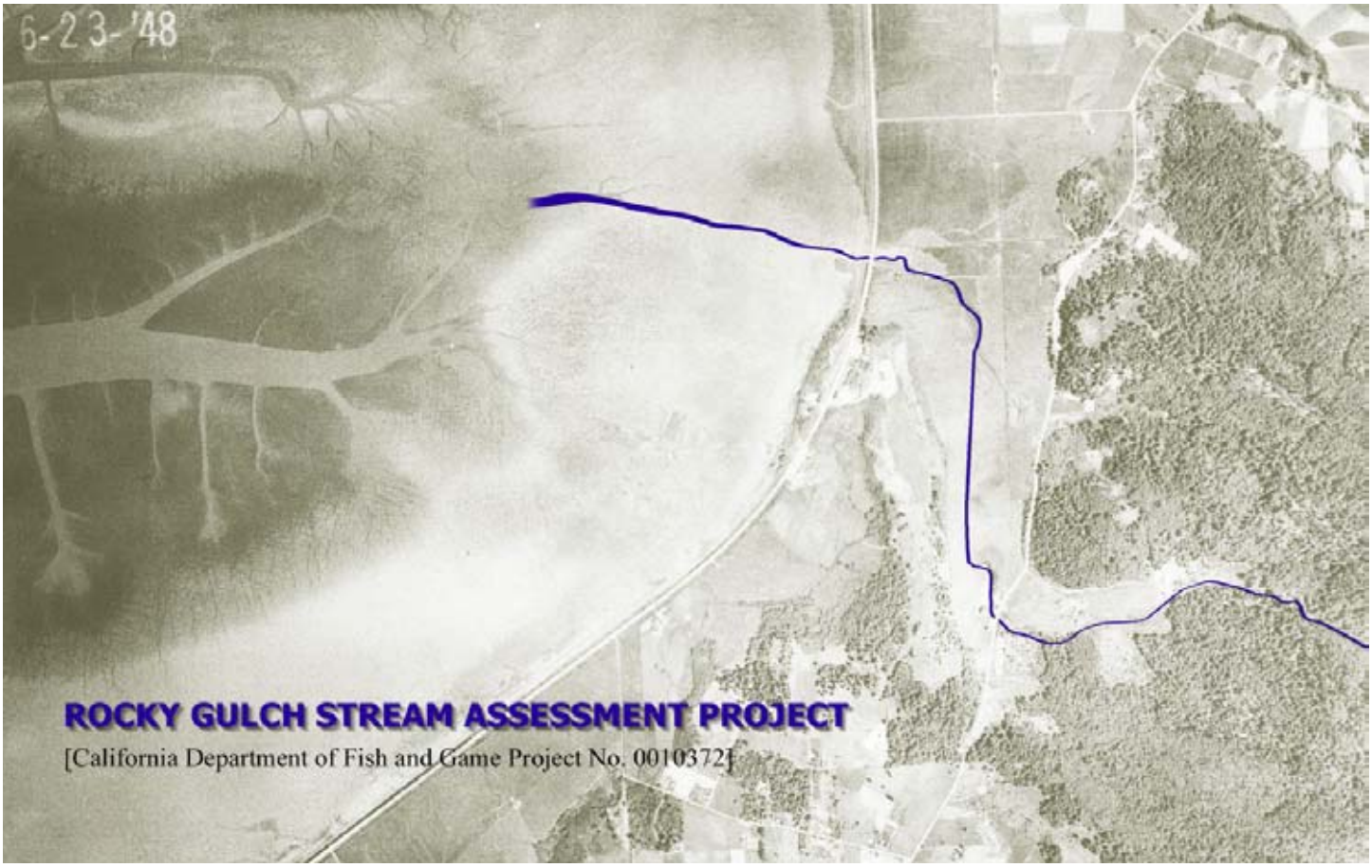

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Acknowledgements

This project is an important step for Rocky Gulch: restoring native salmon and steelhead populations to their former habitats. Achieving this goal will not be possible, however, without the support and cooperation from landowners along Rocky Gulch. I thank Roger and Johanna Rodoni for allowing access to their property, taking time to meet and review our recommendations, and especially for agreeing to allow Phase I of our recommendations to be implemented (if funded). I also thank Bill Hole and Ginni for agreeing to allow the small culverts to be removed and riparian vegetation to re-establish where the stream passes through their property. Upstream landowners played a smaller role, but no less importantly are supportive of all efforts to restore salmonids to Rocky Gulch, and their support is appreciated. I thank Robert Halvorsen and Dave Schneider for allowing access to their property upstream of the barrier culvert to assess the present condition of habitat in this reach. And finally, I thank Mr. John Schwabe and the Department of Fish and Game for their support in funding this project.

1 INTRODUCTION

Few watersheds along the Northcoast of California escaped impacts during the past century of land-use conversion and resource extraction, but rarely does a watershed as small as Rocky Gulch (one square mile) embody so many historical impacts and contemporary issues (Figure 1). As early as 1885, the removal of old growth redwood forests began in Rocky Gulch [Daily Humboldt Standard (23 April 1885) "Logging operations are about to be commenced on Rocky Gulch by Wm. Carson."]. The original railroad grade, which is now Old Arcata Road, was constructed in the late 1800's. This large dike bisected the upper watershed from its lower valley, seasonally flooded wetlands, and estuary. By 1950, timber milling sites and wood processing facilities had been constructed, the entire bottomlands had been converted from wetland and estuarine habitat to pasture for cattle grazing, and residential development had begun. The Old Mill Site upstream of Old Arcata Road dammed and diverted Rocky Gulch and tributaries into ponds, and contributed enormous sediment inputs into the creek (Figure 2). Logging operations were so calamitous that citizens and the Humboldt County District Attorney's office in 1954 successfully sued the logging operation of Rasor and Sons, and were awarded damages of $4,000!

In 1962, California Department of Fish and Game biologist Ervin Martindale wrote of Rocky Gulch:

> *"…Rocky Gulch ranges through a debris strewn water course. The head waters (sic) are circumscribed by a relogged canyon, below the logged over area"; "In the upper 700 yards of survey, one continuous tangle of logs and debris, an estimate was taken"; "33 recorded log jams"; "…no salmonids observed in the area surveyed"; "[I] suggest that some sort of controls be established to prohibit these conditions from occurring again here and elsewhere".*
>
> --Ervin Martindale, February 21, 1962; CDFG Survey of Rocky Gulch --

As with other watersheds with similar land use legacies, these impacts altered or destroyed numerous native habitats, particularly instream salmonid habitat, bottomland wetland areas, and highly productive estuaries that were so critical as rearing habitat for juvenile salmonids. In Rocky Gulch, beginning at the Humboldt Bay confluence, the entire 1.1 miles of creek traversing the bottomlands have been channelized since at least 1948 (Figure 3), and an additional half mile of low gradient, meandering reach with high quality spawning habitat was severely impacted by the Old Mill.

Presently, the clash between restoration and land conservation on the one hand, and pressures for residential development on the other, has begun to play out in Rocky Gulch. A major subdivision was completed in 1993 in the lower watershed, and the current high value of rural land has made development even more attractive.

Despite the persistence of numerous problems, including a moderately high fine sediment load, blocked migratory access, and limited estuarine rearing areas, Rocky Gulch has enormous potential to turn the corner and be restored to once again sustain native coho salmon and steelhead populations. Ievaluated instream habitat from Old Arcata Road (Station 60+00) to the hardrock quarry (Stn 104+00), beginning approximately 2.0 miles upstream of the Humboldt Bay confluence. Apart from short reaches with overly confined channels and other remnant impacts from the logging operations, there appears to be abundant high quality habitat (Figure 4). Icounted at least 32 pools with maximum depths between 2 ft and 2.5 ft that would provide winter juvenile coho habitat. Spawning gravels are equally abundant. Large wood, root wads, undercut banks, and other channel complexity elements are also abundant within the bankfull channel. The riparian understory and redwood canopy have had several decades of recovery, and numerous subdominant species are present, including, Sitka spruce (*Picea sitchensis*), Douglas Fir (*Pseudotsuga menziesii),* and Red Cedar (*Thuja plicata*).

The objectives of this project are to:

- assess migratory access, habitat conditions, and restoration needs of Rocky Gulch;
- develop site-specific recommendations/conceptual designs for habitat restoration and protection that have a high likelihood of improving anadromous salmonid habitat;
- prioritize restoration actions;
- coordinate conceptual plans and recommendations with landowners, resource agencies, and the scientific/restoration community to assure their support;
- present our stream and habitat assessment to CDFG.

This project should improve habitat conditions and help restore populations of coho salmon and steelhead. This project will coordinate various efforts of private landowners, non-profit organizations, and government agencies by providing a planning document to guide restoration efforts. This project has received funding support from the California Department of Fish and Game, Fishery Restoration Grants Program, and contract support from Mr. John Schwabe, Fish Habitat Specialist. I extend my appreciation for this assistance.

2 PHYSIOGRAPHIC SETTING

Rocky Gulch is a 1.3 square mile watershed that drains into North Humboldt Bay approximately 6 miles north of Eureka, CA (Figure 1). The headwaters and most of the lower watershed are densely forested with redwoods, with sparse Sitka spruce, Douglas fir, and red cedar. The watershed extends from its headwaters at approximately 1,000 ft elevation along Greenwood Heights Ridge in a northwest and west direction, and intersects Old Arcata Road at approximately 15 ft elevation. The stream crosses under Old Arcata Road approximately 4 miles south of Arcata (6 miles north of Eureka), traverses the bottomlands (diked former tidelands) now used as cattle pasture for approximately 1.1 miles, then intersects US Hwy 101, where it passes under Highway 101 through a large concrete culvert. There are no large tributaries to Rocky Gulch upstream of Old Arcata Road, but there are several small perennial gulches. Below Old Arcata Road, at least three unnamed tributaries (two ephemeral gullies, and one perennial creek) join Rocky Gulch in the bottoms, that together add an additional half square mile to the watershed. Rocky Gulch flows through a tidal flood gate and joins a second tributary, Washington Gulch (1.0 mi^2), just before passing under Hwy 101 and entering Humboldt Bay. Mean annual precipitation for Rocky Gulch is estimated to be 39.8 inches per year.

Rocky Gulch watershed is nearly entirely privately owned, and supports timber production, agriculture, cattle ranching, and rural residential development. The portion of the watershed upstream of Old Arcata Road is mostly forested with redwood and mixed hardwoods, and was logged probably in the late 1950's and 1960's. Remaining timber is mostly third-growth redwood forest. The area is zoned Timber Production Zone (TPZ) with 40 acre minimum parcel size, and will likely receive minimal development in the future. Simpson Timber Company owns property in the headwaters. There are several residential lots in the lower portion of the watershed, centered on Old Arcata Road and Rocky Creek Road, all totaling less than 20 acres. Below Old Arcata Road, Rocky Gulch traverses a broad pasture grazed by cattle. This property belongs to Roger and Johanna Rodoni.

3 GEOLOGY

The Rocky Gulch watershed borders the fringe of the tidal zone of North Humboldt Bay, sandwiched between the larger Jacoby Creek and Freshwater Creek watersheds to the north and south, respectively. The watershed ranges in elevation from Mean Sea Level to just over 1,000 ft. Two main lithologic units have been mapped in the watershed, the Pleistocene Hookton Formation and the Franciscan Formation. In addition, the lower watershed contains alluvial bay-margin fill (BGC 1991). The Hookton Formation (Figure 5, symbol Qh) is a non-marine, generally well sorted, median-grained, moderately cemented sandstone with some clay and gravel. This Pleistocene formation rests atop rocks of the Cretaceous-Jurassic Franciscan Formation (Figure 5, symbol KJfs). The Franciscan Formation is a well-consolidated sandstone, siltstone, and shale, with minor conglomerate and exotic lithologies. Franciscan rocks are generally highly sheared and structurally deformed (Kelley 1984). The Freshwater Fault, a pre-Wildcat Group (i.e., pre-Tertiary) high angle reverse fault, cuts through the site within Franciscan rocks, hidden beneath the Hookton Formation and younger colluvial soils (Kelley 1984). The fault appears to be inactive, but mapping suggests late Cenozoic reactivation has occurred.

4 OVERVIEW OF HISTORICAL LAND USE ACTIVITIES

Throughout its recent history (past 150 years), Rocky Gulch has been used primarily for timber production in the forested portion of the watershed, and cattle grazing in the bottomlands. Research conducted by local historian Susie Van Kirk uncovered ownership records in the Humboldt County Recorder's Office describing William Carson's acquisition of lower Rocky Gulch before 1865, when it came under the Dolbeer & Carson name. Timber harvesting began as early as 1885. As indicated by the numerous old growth redwood stumps in the lower watershed, the virgin forest contained plentiful timber and because of its relatively close proximity to Humboldt Bay and local mills, was likely quite attractive to early timber operators.

Iobtained file reports at California Department of Fish and Game. These reports contain sporadic information beginning with CDFG warden reports from 1957 describing a civil lawsuit against a local timber company for violations to logging practices . Some of the salient information is encapsulated below:

- January 4, 1957: John O. Finnegan, CDFG Warden, in Deposition to District Attorney: "At approximately 10 AM, December 14 [1956] I received a radio call via the sheriffs office to investigate heavy mud pollution in the Rocky Gulch Creek near the Williamson Ranch on the Bayside Road."
- 1962: Ralph McCormick, Fisheries Manager II; "Rocky Gulch Creek was recently extensively damaged by logging activities. Due to extensive erosion and siltation, the spawning populations of anadromous salmonids were decimated and the stream rendered unfit for spawning for some time to come."
- January 1962: Ralph W. Scott, Deputy Attorney General, State of California; "…It has been 5 years now since the siltation first took place, and when I saw the stream a few weeks ago the gravels were compacted …and will not be adaptable for fish spawning until the lapse of an additional period of time."
- February 1962: CDFG survey by Ervin Martindale "…Rocky Gulch ranges through a debris strewn water course. The head waters (sic) are circumscribed by a relogged canyon, below the logged over area"; "In the upper 700 yards of survey, one continuous tangle of logs and

debris, an estimate was taken"; "33 recorded log jams"; "…no salmonids observed in the area surveyed"; "Suggest that some sort of controls be established to prohibit these conditions from occurring again here and elsewhere".

- August 1962: CDFG News Release announcing settlement of litigation brought by the Department on Rasor and Son, Inc. and Pacific Timber, Inc., for "damages brought about in the winter of 1956 by unlawful and negligent pollution of the creek with mud and debris from logging operations". The State was paid $4,000 in settlement; News Release states that Rocky Gulch was utilized as a spawning area by "at least 50 adult silver salmon each year with a production capacity of 45,000 fingerling salmon."
- June 1964: CDFG survey, no salmonids observed, spawning gravels available but "embedded in heavy silt"; extensive pollution runoff from the mill (Precision Lumber Mill); numerous stream obstructions; ¼ mile section in which the creek flows underground; "from the mill east to the headwaters the creek is impassable due to brush and timber in the stream";
- October 1989: Report from Humboldt County Planning Director describing unauthorized hard-rock mining from a quarry site on Rocky Gulch;

5 CONTEMPORARY WATERSHED AND LAND USE CONDITIONS

5.1 Reach Delineation and Descriptions

The following section describes the discrete reaches and features along Rocky Gulch from the seaward side of the culvert at Humboldt Bay to the hardrock quarry at approximately 200 ft elevation in the watershed (1.3 miles upstream of Old Arcata Road). Station numbering follows engineering notation, based on linear distance in feet from Stn 0+00 upstream of the Rocky Gulch confluence with Humboldt Bay, e.g. Stn 6+00 is 600 ft upstream of Humboldt Bay.

Tidal Pool [Stn 0+00 to 6+00] (Figure 6)
This segment extends from the seaward invert of the Hwy 101 culvert to the tidegate. This area has been designated as the Tidal Pool due to the influence of Humboldt Bay tides. Based on surveys of water surface elevation on both sides of the Hwy 101 culvert, the culvert does not affect the tide stage inside the tidal pool. The tidal pool (approximately 2 acres) is flanked by dikes, fills with seawater during each high tide, and receives freshwater runoff from surrounding pastures through several small gated culverts, as well as collecting runoff from both Rocky Gulch and Washington Gulch.

Tidegate [Stn 6+00] (Figure 7)
This tidegate, built in the early 1900's, was designed to prevent all seawater from inundating pastures behind the gate, but still allow high stream runoff to drain into Humboldt Bay. Because of the old and neglected condition of the tidegate, most tidewater leaks through the gate; water surface elevations inside the gate are usually only slightly lower than tide elevations, until the tide crests, and water surface elevations equilibrate. However, the tidegate is an effective barrier to upstream anadromous salmonid migration. Although there are occasions when fish passage is possible, primarily during ebb tide when escaping tidewater pushed the gate open, water velocities around and under the gate are usually high, and spaces are small for fish to swim through. The brief periods of time when the gate is passable is also out of sync with the migratory movements of adult salmon and steelhead, who move in (upstream) on the crest of moderate to high tides.

Lower Bottoms [Stn 6+00 to 17+00] (Figure 8)
This section of creek is defined by the extent of tidal influence, its narrow, channelized condition, and primarily salt-tolerant vegetation. Regular seawater intrusion has a beneficial effect of reducing sediment deposition by pulling fine sediments out to the bay, helping the channel remain free of vegetation. Banks are vertical and undercut from tidal action; the channelbed is composed of fine silts and clay. The left bank dike (south side of the channel) is approximately 5 ft higher than the channel thalweg, and water rarely overtops the dike. Cattle have access to the dike, but cannot access the channel in this location because of the steep banks. The north side of Rocky Gulch, sandwiched between Rocky Gulch and Washington Gulch, has limited grazing value as pasture, but has not recovered as high quality marsh.

Middle Bottoms [Stn 17+00 to 33+00] (Figure 9)
This reach is the most severely channelized and straightened section of creek traversing the pastures, with two straight sections of creek and an exact 90° bend approximately following property boundaries. Tidewater does not reach this far up the channel. Fine sediment tends to settle out in this low gradient reach, allowing vegetation to grow in the channel. The channel banks and dikes are eroded from cattle. Cattle frequently access the channel to water. No riparian vegetation is present along the downstream portion of this reach, but willow and alder grow thickly along the channel upstream of the 90° bend. The upstream boundary of this reach is the point where Rocky Gulch turns west and flows away from Old Arcata Road.

Upper Bottoms [Stn 33+00 to 61+50] (Figure 9)
The upper bottoms reach follows the base of Old Arcata Road along the eastern side of the pasture. This reach is severely confined by a poorly maintained dike along the left bank, with the total stream corridor as narrow as 20 ft in many places. The dike is trampled down in several locations, allowing high winter runoff to overtop the dike and flood into the pasture. The reach is also heavily vegetated along nearly the entire half-mile, with both understory riparian hardwood species and conifer canopy of redwood. At the upstream end of this reach is a short segment that makes a “U” shaped loop around an old ranch house. This segment has no dikes confining the channel, has been maintained to prevent riparian vegetation from growing along the banks, and has several undersized culverts allowing foot passage to the garage. There are several buildings close to the channel. This reach terminates at the culvert passing under Old Arcata Road. The Old Arcata Road culvert was among those culverts inventoried by Humboldt County, and was determined not to be a barrier to fish passage. The culvert is undersized, however, and contributes to flooding of the pasture to the north of the creek. Humboldt County Public Works Department has therefore included replacing this culvert as part of the larger Old Arcata Road rehabilitation project.

Lower Spawning Reach [Stn 61+50 to 78+37] (Figure 10)
This reach passes through a lightly developed residential area that was part of a residential subdivision completed in 1993. There are five parcels within the subdivision along the stream and valley, two of which are still undeveloped lots. Three lots have houses set back from the channel. The remaining watershed area surrounding these smaller parcels are all 40+ acre parcels zoned for timber production (TPZ). The residential sites have had minimal impacts on the stream, and apart from the 100 ft section directly upstream of the Old Arcata Road culvert which is channelized and overgrown with vegetation, most of this reach is relatively healthy, with several pools and numerous spawning sites. This reach terminates 1,700 ft upstream of Old Arcata Road at the barrier culvert that blocks upstream anadromous fish access.

Upper Spawning Reach [Stn 78+37 to 105+00] (Figure 10)
This reach does not currently support anadromous salmonids. The quality of habitat in this reach is outstanding, however, and is the primary justification for all investment in downstream restoration.

I consider restoring fish access to this reach a high priority. The habitat in this 3,000 ft section of Rocky Gulch may sustain a healthy population of coho salmon and steelhead, in addition to the already present cutthroat trout population. The surrounding redwood forests have all been harvested several times, and at present are recovering from the last period of harvest which likely removed most remaining second growth forest. The stream flows in a slight northwest direction through a narrow "V" shaped valley, with ample mixed riparian understory and tall conifer canopy composed primarily of redwood with mixed red cedar, Douglas fir, and Sitka spruce. Woody debris is plentiful in the channel. There are several natural cascade and log-jam features that may slow anadromous migration, but are passable during moderate and higher winter baseflows. Water temperatures are optimal year-round. The upstream-most barrier to adult salmonid migration is likely a 4 ft cascade near the hardrock quarry at approximately station 99+00).

5.2 Stream Hydrology

I established a record of streamflow hydrology for Rocky Gulch in two ways, first by establishing a gaging station, and second by transforming USGS and other streamflow records from nearby watersheds. The gaging station, installed on October 13, 2001, is located at Stn. 74+20, approximately 1,400 ft upstream of Old Arcata Road. The gage, currently in its second year, consists of 6.33 ft staff plate mounted on 3-inch angle iron, combined with a Global WL14 WaterLevel Logger (pressure transducer) calibrated and programmed to read stream stage at 15 minute intervals. I developed a stage-discharge rating curve for the initial installation location (Figure 11) for October 13, 2001 to January 25, 2002. This location was abandoned following a large storm that deposited a large pulse of sediment, burying the staff plate and pressure transducer. The staff plate was relocated to a more stable site in a pool approximately 50 ft upstream. I am currently developing a new stage-discharge rating curve (Figure 11) at this new staff plate location.

The hydrograph for the first year of operation (Figure 12) allowed us to compare the measured daily average runoff from Rocky Gulch to other local stream gages. These included gages at Morrison Gulch and Sullivan Gulch, and the USGS gage at Little River near Trinidad (Station 11-481200). I selected the USGS Little River gage for conversion to Rocky Gulch (based on drainage area) because of the relatively long period of record available at this gage (1956-present). Conversion of daily average flow based only on drainage area is a common, but relatively crude method of obtaining a flow record. I used the daily average hydrograph for the overlapping period of record (October 13, 2001 to March 21, 2002) and adjusted the Little River data to achieve the best fit of the data (Figure 13). The conversion factor (0.42) was less than a 1:1 ratio of drainage area, likely due to the considerable differences in mean annual precipitation (Little River = 70 in/yr; Rocky Gulch= 40 in/yr). Some variability is also evident in the baseflow and peak flow periods (Figure 13), likely due to deficiencies in the Rocky Gulch rating curve at these lower and higher flow ranges. But this conversion allowed us to obtain some useful daily average flowdata for Rocky Gulch. The synthetic flow data for Rocky Gulch will continue to be modified and updated as additional data are collected at the Rocky Gulch gage. Finally, I used these data to develop a flow duration curve for Rocky Gulch (Figure 14).

I obtained flood frequency estimates for several surrounding watersheds developed for a culvert replacement project on nearby Morrison Gulch (tributary to Jacoby Creek) as well as flood frequency estimates for Rocky Gulch prepared by engineers at Humboldt County Public Works Department for a planned culvert replacement project on Rocky Gulch at Old Arcata Road (Table 1). These flood frequency analyses provide estimates for the 100-yr flood, which is of interest in the design of culverts. These data will also help design restoration projects on Rocky Gulch, particularly for the upstream barrier culvert and for modification to the tidegate. For Rocky Gulch, two of the three

estimates for the Q_{100}, 344 cfs and 378 cfs (from Waananen and Crippen , and Rational Method, respectively), are quite similar and are probably more realistic than the Log-Pearson III estimate of 950 cfs based on Jacoby Creek gaging records. For the design of replacement options for the barrier culvert, engineers used a 100–year flood estimate of approximately 350 cfs. All the watersheds listed in Table 1 have higher mean annual precipitation than Rocky Gulch, resulting in relatively higher average per-unit runoff.

5.3 Salmonid Populations

The decline of coho salmon populations in north-coastal California has been well documented in recent years (Nehlson et al 1991, Brown et al. 1994). Coho stocks are estimated today to be less than 6% of their abundance in the 1940's (Brown et al. 1994). Reasons for the declining coho population include stream alterations and freshwater habitat losses brought on by poor land-use practiced, especially the effects of logging and urban development, blocked access to freshwater habitat, the influence of introduced hatchery stock on the genetic integrity of native populations, introduced diseases, overharvest, and fluctuating climatic conditions Nehlson et al 1991, Brown et al. 1994).

In 1993, coho salmon in California, Oregon, Washington, and Idaho were included in a petition for listing under the Federal Endangered Species Act (ESA). The Southern Oregon/Northern California Coasts (SONCC) Coho Ecologically Significant Unit (ESU), which includes Humboldt Bay (and therefore Rocky Gulch) coho populations, was accepted for listing as **threatened** on June 5, 1997. The conclusion of the updated NMFS status report (NMFS 2001) was that the California portion of the SONCC was likely to become endangered in the foreseeable future. In addition, the recent status review of coho salmon populations north of San Francisco completed by the California Department of Fish and Game (CDFG 2002) "did not find any evidence to contradict the conclusions of previous status reviews that coho salmon populations have suffered declines in California" and conversely found new evidence to support previous conclusions. The CDFG recommended coho be listed under the State ESA as **threatened**.

During completion of this Rocky Gulch Stream Assessment survey, I gathered information to assess the historical presence and abundance of coho salmon (and secondarily steelhead) in Rocky Gulch. Most information came from CDFG file reports from the Eureka field office, discussed in Section 3.1 above. The best conclusion that can be drawn from this information is that coho salmon and steelhead were definitely present historically in Rocky Gulch, a viable population persisted at least through the late 1950's and into the early 1960's, heavily impacted by logging and milling activities in the 1960's. I spoke to long-time residents in the Rocky Gulch watershed who recalled a once abundant coho salmon run. Sometime during or soon after the 1960's when Rocky Gulch was severely impacted by logging operations, the coho salmon and steelhead populations were extirpated from Rocky Gulch.

CDFG conducted electrofishing and snorkel surveys in 2001/02 to determine the presence/absence of coho salmon in Rocky Gulch. On 5/22/01 CDFG biologists and I electrofished 10 pools in the reach directly downstream of Old Arcata Road, and 10 pools in the reach directly downstream of the barrier culvert. In both locations rainbow trout and cutthroat trout were observed, but no coho were observed. We also captured sculpin (*Cottis* spp.), Pacific lamprey larvae (*Lampetra tridentata*), and Pacific giant salamanders (*Dicamptodon ensatus*).

5.4 Habitat Surveys

I surveyed Rocky Gulch using the habitat inventory methods described in the CDFG California Salmonid Stream Habitat Restoration Manual (CDFG 1998). Surveys were conducted in three sections: (1) the lower reaches from Hwy 101 across the bottoms to the intersection with Old Arcata

Road (Stn 60+00), (2) the lower gradient alluvial valley reach from Old Arcata Road to the barrier culvert at 77+00, and (3) the confined reach from the barrier culver to the hardrock quarry (Stn 104+00). A total of 4,600 ft of Rocky Gulch was habitat typed (Table 2). Surveys were all conducted during summer low flow conditions, at flows estimated less than one cfs. For the upper two surveyed sections, stations were established using a hip-chain to measure cumulative distance from the Rocky Gulch confluence with Humboldt Bay (Stn 0+00). Each habitat unit was identified using 20 different habitat unit types (CDFG 1998). For each pool unit identified, the average and maximum depths were recorded. For approximately every tenth habitat unit, additional habitat features were recorded, including substrate composition and embeddedness, bank composition and vegetation type, instream and overhead shelter, and percent total canopy. I recorded all other information such as location of fence-lines, culverts, tributary confluences, presence of large woody debris jams, and potential natural migration barriers such as cascades or other obstructions.

While still manifesting impacts of past logging impacts and sedimentation, Rocky Gulch nevertheless contains abundant, good quality salmonid habitat upstream of Old Arcata Road. Pools are plentiful. The forest canopy is maturing, composed of alder and willow along the stream banks and redwood along the hillslopes. Exposed substrates are well sorted, composed of semi-embedded gravel and small cobble in the lower alluvial reaches, and transitioning to coarser gravel and cobble, with intermittent boulder and exposed bedrock in the upper sections. Fine silt and sand are abundant in pools and on pool tails, but I observed only minor fine sediment deposition on floodplains. In the lower reaches, alders were rooted into the channel. Cover provided by undercut banks and large wood pieces was abundant in some locations, but in general was sparse. Low gradient riffles dominated the habitat unit types, comprising 24 units and 1,367 ft of channel. I observed a total of 32 pools, dominated by mid-channel pools and plunge pools, most of which were caused by embedded tree trunks and root wads. Pool units totaled 858 ft, or 26.5 % of the reaches assessed. Mean pool depths ranged from 1.0 to 1.5 ft, with maximum pool depths generally ranging between 2.0 and 2.5 ft. Only the barrier culvert plunge pool exceeded 3.0 ft, with maximum depth of 4.2 ft. Several pools were formed by old-growth redwood stumps or abandoned old-growth logs left behind by the original timber harvest. Two cascade complexes were observed, at Stns 94+70 and 99+20. Both of these units may inhibit or block upstream migratory access to coho and steelhead, depending on flow conditions.

I installed an Onset Optic Stowaway temperature recorder (thermograph) at the gaging station site on Rocky Gulch. The thermograph has operated continuously since [date], recording water temperature at 15 minute intervals. As is expected in Humboldt Bay watersheds, stream water temperature is favorable to anadromous salmonids, ranging from 50°F to 56°F .

5.5 Fish Passage Evaluations and Monitoring Data

5.5.1 Rocky Gulch Tidegate

The primary focus of this project was to study the condition of Rocky Gulch Creek for its potential to support anadromous salmonid populations, primarily coho salmon. Because most problem I identified in Rocky Gulch are related to fish passage and the condition of the channelized portion of stream as it traverses the converted bottomlands, monitoring focused on the lower reaches. I evaluated the following issues:

- tidal passage through the culvert under Hwy 101
- tidal stage and extent of inundation within the tidal pool
- fish and tidewater passage at the tidegate on Rocky Gulch
- extent of saltwater intrusion and peak tide stage upstream of the Rocky Gulch tidegate
- temperature and salinity conditions in the lower bottoms reach

The culvert passing under Hwy 101 is 200 ft long, in two sections including a concrete box culvert that passes under the highway, and a corrugated metal pipe culvert that passes under the railroad grade that parallels Hwy 101 to the west. Our primary interest was in determining if this culvert "muted" in-coming and out-going tides, thus limiting the volume and stage height of seawater flowing into the tidal pool and impinging on the Rocky Gulch tidegate. This information is critical in re-designing a tidegate structure to allow fish passage. I surveyed the water surface elevation on the Humboldt Bay side of the culvert and simultaneously on the tidal pool side of the culvert at a nearly maximum tide stage height of 8.2 ft MLLW (on 1/29/02 at 11:30). All land and water surface elevation surveys were tied into the Cal-Trans benchmark located on the Rocky Gulch Hwy 101 concrete culvert abutment on the east side of the freeway [National Geodetic Survey Database provided the survey control datum of 8.93 ft NAVD 88]. Our survey measured a Humboldt Bay water surface elevation of 7.29 ft and a tidal pool elevation of 6.99 ft, a 0.3 ft difference in tide stage. Given the near maximum tide stage, this difference is relatively insignificant and I concluded that that Hwy 101 culvert has very little muting effect on tide stage.

A Global WL-14 Water Level Logger was installed in the Rocky Gulch tidal pool at the downstream side of the tidegate. I collected tide stage data at 15 minute intervals, for nearly a month (1/26/02 to 2/21/02). I compared our data to the NOAA data (Station 9418767 NORTH SPIT, HUMBOLDT BAY , CA), then adjusted the regularly published North Spit tide data to correspond to our data (Figure 15). I then adjusted the tide data in MLLW to NAVD88 using the conversion of 1.07 ft published by USGS for the Mad River Slough Bridge (which I believed to correspond relatively well to our site on Rocky Gulch). This conversion thus provided the entire range of tide stage in the same coordinate system used to survey topography of the pasture. These data can be used during our eventual tidegate design to estimate (or model) the extent of tidal inundation beyond the tidegate. I converted one year of tide data from the North Spit station (3/1/01 to 3/1/02) to our NAVD 88 datum, then developed a tide-stage duration curve that will allow prediction of the duration of tide stages (Figure 16). These data will allow us to estimate how much time the tide stage at the tidegate is at or above a certain elevation (in NAVD88).

I evaluated habitat and passage conditions in the Lower Bottoms Reach during a 3.5 ft tide on 10/11/01. During this survey I collected salinity measurements to determine the extent of tidal influence. Salinity just inside the tidegate (Station 6+00) measured 18.9 ppt with minimal tidewater/freshwater exchange through the tidegate. At station 9+00, water was still saline at 16.8 ppt., but by station 11+00 (500 ft upstream of the tidegate) salinity had dropped to 2.8 ppt. At station 16+00 (near the first 90 degree bend), water was nearly entirely fresh (at low tide), with salinity measuring 0.5 ppt. Our observations of the transition of vegetation in the channel indicate that the effects of seawater inundation reach to approximately station 20+00 to 23+00 (Figure 3). I also sampled salinity in small distributary channels along the west edge of the pasture and found salinity as high as 24 ppt, indicating tidal seepage through a secondary floodgate that passes through the south dike at Rocky Gulch station 9+50. Water temperature during the survey ranged from 62°F at the tidegate to 59.9°F at station 16+00.

Peak stage recorders were placed at 4 locations along the Rocky Gulch bottoms to determine the maximum stage height (elevation in feet) of the creek where it is influenced by the tide. Stage recorders were constructed of 2 inch PVC pipe, cut 4 ft long, with permanent cap on the bottom and screw-cap on top. Inside the pipe was inserted a 4 ft piece of 1/2x1/2 redwood stick and a cup-full of ground up cork. The bottom of the pipe was perforated to allow water into the pipe. At maximum stage height the cork is carried up the inside the PVC pipe, and as water recedes, the cork sticks to the wood stick, marking the peak stage height. Stage recorders were placed at stations 6+00, 9+50, 16+00, and 23+00. Stage records were surveyed following a peak tide stage of 8.0 ft on 11/14/01. Maximum stages of the four peak stage recorders were all within 0.05 ft of each other, and averaged 6.27 ft elevation (NAVD 88). This corresponds to a tide elevation of 7.34 ft.

During the winter 2001/2 I made numerous observations at the tidegate to determine if fish passage was possible with the existing structure. The tidegate is an old wooden structure (Figure 6) hinged at the top, and when closed, impinges on a 10 ft high concrete wall, with 8 ft high wing-walls and total length of 14 ft. The floor of the tidegate structure is also lined with concrete. The gate allows a substantial volume of tidal water past the gate: at highest tide stage (during winter baseflow conditions on Rocky Gulch) water surface stage inside the tidegate (upstream side) is only slightly lower than the maximum tide stage. Because the tidewater that passes the tidegate does so by seepage through the wooden gate, however, the structure does not allow fish passage during the incoming tide. As the tide peaks and ebbs, water surface stage inside and outside the gate momentarily equilibrate, then the tidewater shifts to flowing out the gate. At this stage, the tidegate does not appear to open adequately to allow passage of fish, and water velocities rushing through and around the tidegate are extremely high. Water turbidity also increases the difficulty for fish to find passage through the tidegate.

The tidegate probably allows fish passage at extremely high Rocky Gulch runoff events. Resident Scott Sway observed one adult salmonid (unidentified species) in 1998 following the peak storm event of November. However, the relatively rare periods of time the tidegate opens wide enough to allow fish passage, during ebb tide at high stream stage, generally are not in synchrony with the upstream movement of adult salmon. The opportunity for fish passage that is reliable enough to sustain viable salmonid populations is severely limited. In summary, our conclusion is that the tidegate is enough of a barrier to salmonid migratory passage to prohibit a self-sustaining salmonid population.

5.5.2 Lower Bottoms Reaches

Upstream of the tidegate, the Rocky Gulch channel is clear and unobstructed for the lower 2,800 ft. A dike on the south and west side of the creek, with pasture at floodplain elevation on the north and east side, confines this section of channel. The maximum extent of upstream tidal inundation, measured in terms of water salinity and vegetation, was observed at approximately station 23+00. Beyond this point, freshwater aquatic vegetation and woody riparian vegetation (willows) clog the channel. At station 33+00, the creek makes a 90° bend that allows a substantial portion of winter streamflow to escape the channel and flow onto the pasture (Figure 3). Water escaping the channel fills the eastside pasture and has no defined return to the channel. If juvenile salmonids were present, they would risk becoming stranded in the pasture. Nutrient loading from pasture runoff also severely degrades water quality in the lower reaches. From station 33+00 to 55+00, the channel is narrowly confined between Old Arcata Road and a dike (Figure 9). The channel is heavily vegetated, aggraded by fine sediment, has numerous partial barriers from small cattle-crossing culverts and vegetation, and may obstruct fish passage. Rearing habitat quality in this reach is impaired by channel confinement, sedimentation, and thick vegetation.

5.5.3 Old Arcata Road Culvert

Rocky Gulch passes under Old Arcata Road at station 60+00 through two 3 ft diameter concrete pipe culverts (Figure 17). Passage at this culvert, assessed during a culvert passage survey conducted by Humboldt County, was deemed passable by adult salmonids. The present undersized culvert regularly floods the upstream 3 acre undeveloped parcel during high flows. Humboldt County Public Works Department has prepared designs for replacing this culvert during planned road improvement works. The new culvert structure, designed by Graham Matthews and Associates for Redwood Community Action Agency (RCAA) will include a 54 ft long steel culvert, 10’8” wide by 6’11” high (Appendix A). A high water overflow channel will follow Old Arcata Road for approximately 300 ft and pass through a smaller existing culvert to rejoin Rocky Gulch (Appendix A).

5.5.4 Lower Spawning Reach

Above the Old Arcata Road culvert, the channel is clear of major obstructions, and would provide adult and juvenile passage for approximately 1,680 ft up to the barrier culvert. The barrier culvert sits on privately owned land and was identified as a total barrier to upstream salmonids migration during Humboldt County culvert inventories. The culvert is a 60 ft long, 4 ft diameter corrugated pipe installed to allow logging road access to approximately 120 acres of redwood timber land. The culvert crossing presently allows access to a single residence. The culvert evert is perched approximately 5 ft above the plunge pool water surface, with large boulder riprap along the pool-head margin. Residual pool depth is 4.2 ft. Water velocities and the outflow height prohibit salmonids from passing upstream. No adult salmonids have been observed at this culvert pool. Designs for replacing this culvert with either a bridge, an open-bottom arched culvert, or an embedded pipe culvert were prepared by local engineers Winzler and Kelley, and are presented as an attachment in Appendix B. Above the barrier culvert, fish passage is possible for an additional 2,000 ft before the channel gradient becomes steeper and several cascades likely block migration farther upstream.

5.6 Topographic Surveys

To aid our preliminary design and project implementation cost estimates, Fred Meyer and I conducted a topographic survey of Rocky Gulch and the lower bottoms from the Hwy 101 culvert upstream to station 33+00 (Figure 18). Surveys were conducted with a total station tied to the Cal-Trans benchmark on the Hwy 101 culvert abutment (Elevation = 8.93 ft NAVD 88). While the topographic diversity through this reach is relatively minor, i.e., the pasture is mostly flat with a gentle slope in the upstream direction, this survey information allows us to: (1) accurately estimate the cut-and-fill volumes that will be required to implement our recommendations in the lower reaches, and (2) develop hydraulic models to predict the extent of tidal inundation with different tidegate design alternatives.

5.7 Long-term Monitoring Sites

Two small sub-reaches, one from each the lower and upper spawning reaches, are long-term stream monitoring sites. These monitoring sites are each approximately 400 ft long and contain a variety of habitat types, mostly pool-riffle sequences in alluvially-formed channels. The downstream study site, designated Site-A, is located at stream stations 73+00 to 77+00, approximately 1,400 ft upstream of the Old Arcata Road culvert, and contains the gaging station installation. I installed and surveyed four cross sections and a longitudinal profile of the channel thalweg and water surface in this reach. Additional monitoring will be added as the stream restoration program moves forward, and will include planmapping of the study site to estimate spawning habitat availability, turbidity and suspended sediment sampling, bulk sampling for particle size distribution, and permeability of spawning gravels. Site B will be established when the upstream barrier culvert is replaced to allow anadromous salmonid fish passage to upstream habitat areas.

6 RESTORATION GOALS AND OBJECTIVES

The overarching goal for Rocky Gulch is to restore anadromous fish access, restore and preserve high quality salmonid habitat, and revive robust salmonid populations (coho salmon and steelhead) from Humboldt Bay to approximately the hardrock quarry located 0.8 miles upstream of Old Arcata Road. This goal entails the following objectives:

- restore fish passage at the Rocky Gulch tidegate next to Hwy 101;

- rehabilitate the Rocky Gulch bottoms from Hwy 101 to Old Arcata Road, functionally separating the pasture and cattle grazing from the creek by excluding cattle from entering the creek channel, providing a wider creek channel and floodplain, and rehabilitating existing dikes to better contain winter flood flows and reduce potential fish stranding and flooding in the surrounding pasture;
- re-create an estuary to provide high quality rearing habitat, and restored freshwater and salt marsh wetlands in the lower section of the bottoms, with seawater intrusion controlled by the tidegate structure;
- increase riparian and conifer species diversity along the Rocky Gulch bottoms;
- replace the Old Arcata Road culvert to improve fish passage and reduce flooding;
- replace the upstream barrier culvert to restore fish access to upstream habitat;
- preserve the quality of fish habitat in the portion of Rocky Gulch upstream of Old Arcata Road.

While our restoration goals and recommendations are intended to improve conditions for anadromous salmonids in the Rocky Gulch watershed, I acknowledge that the land over which Rocky Gulch traverses is almost entirely privately owned. It is also "working land" used as pasture for raising cattle, and for residents of the Bayside community. I have therefore attempted to develop solutions and make recommendations that balance the needs of both the local community and the fish and wildlife that are native to the watershed. I do not intend to impose any restoration actions on unwilling landowners, but simply aim to work with landowners, the local community, restoration advocates, and funding agencies to develop and implement solutions acceptable to all.

7 CONCEPTUAL RESTORATION DESIGNS AND RECOMMENDATIONS

Recommended restoration actions for Rocky Gulch are described in the following 9 tasks (A-I), presented sequentially from Hwy 101 upstream (Figure 19). I have made considerable effort to coordinate these recommendations with the Department of Fish and Game (the funding agency), along with private landowners in the lower portion of the watershed, regulatory agency personnel, and individuals/groups within the local science and restoration community, to assure that the recommended approach and specific tasks are reasonable, implementable, and acceptable to all parties potentially affected by these restoration actions. As with all habitat restoration and conservation efforts to sustain or restore at-risk species, the highest priority is to preserve the healthy remaining portions of habitat that already exist, then try to rehabilitate the impacted or less functional areas to better conditions. Some tasks, such as restoring fish passage, are higher priority than others, but all tasks are deemed necessary to achieve the overarching goal of restoring and sustaining robust populations of coho salmon and steelhead to Rocky Gulch. Additionally, because of the inherent uncertainties and the relatively limited information that accompany stream restoration, I have attempted to provide opportunities for learning and expanding our understanding of salmon restoration while simultaneously implementing on-the-ground restoration actions. The tidegate design, and the emphasis on restoring estuarine rearing conditions in the lower portion of the creek, are two examples of this focus on science-based restoration.

I recommend a three-phased implementation of these tasks. **Phase I** should include rehabilitation of the entire bottoms, including replacing the tidegate with a fish-friendly structure, restoring an estuary for salmonid rearing and marsh habitat, and rehabilitating the creek channel as it traverses the pasturelands (Figure 19). This phase will therefore allow consistent fish passage all the way across the

Bottoms to Old Arcata Road, thus removing the most significant hurdle to restoring viable salmonid populations. **Phase II** should include replacing both the Old Arcata Road culvert and the upstream barrier culvert to allow fish access to all naturally available habitat (Figure 19). This phase would also include some minor stream rehabilitation work to improve salmonid habitat and stream function. **Phase III** should provide adequate funding to monitor the effectiveness of phases I and II. Monitoring is a key component of restoration often overlooked in stream restoration. Monitoring the proposed tidegate, restored estuary, replaced culverts, and rejuvenated habitat will allow valuable information to be gained that is useful for other project designs. I have also included "preservation" in this task as an essential (but unfunded) task.

7.1 Phase I: Rocky Gulch Bottoms (tasks A-D)

7.1.1 Task A: Replace the Rocky Gulch Tidegate

The Rocky Gulch tidegate is old, does not allow fish passage, but ironically allows tidewater to pass through nearly uninhibited. The landowner was not willing to allow the tidegate to be removed completely, but has agreed to allow the tidegate to be replaced with a tidegate that will simultaneously allow fish passage.

Design of fish-friendly tidegates has only recently begun to receive attention, and very few structures have actually been implemented. I evaluated three generally different design options before settling on a recommended approach: (1) standard Waterman flapgates equipped with levered floats that keep the tidegate open until a targeted tidal stage height is reached, which then activates the floats to close the tidegate until the tide recedes; (2) pet-door style tidegates that have a smaller two-way door within the larger tidegate door, that is opened either by a float or simply by the current passing through; (3) muted-cycle structure that is simply an open constriction allowing a limited volume of water to pass, but would allow free passage of fish when tidal stage height exceeds the bottom elevation of the sill; this structure would be installed side-by-side with a conventional flapgate (no floats) to allow rapid and free flow of water in the seaward direction during tidal recession and/or stream flooding (Figure 20).

I recommend a muted cycle tidegate side-by-side with a Waterman flapgate (Figure 20) be installed on Rocky Creek at a site approximately 100 ft upstream of the present tidegate location. The muted cycle design (with conventional flapgate) has several distinct advantages over other fish-friendly designs, including, permanence, limited maintenance, and low vulnerability to damage, clogging, or other problems. The muted cycle design also remains "open" at all times, providing migratory fish the maximum opportunity to pass through the structure. In addition to superior fish passage, the muted cycle design allows partial control over the volume of seawater allowed to pass through the "window" by adjusting the dimensions of the opening. This feature is important in conjunction with Task B: by controlling the volume of seawater passing behind the tidegate (by design and by trial-and-error) we can target desired salinity levels in the restored estuarine environment inside the tidegate (Figure 21). Details regarding the dimensions of the passage window, elevation of the window sill, and the flapgate size, will be determined by engineering evaluations during the design phase of the tidegate implementation. Following the landowner's recommendation, I also suggest the tidegate be located approximately 100 ft upstream of the existing site, in a straight, constricted section of channel. This location will allow more direct and laminar flows through the flapgate and passage window, and will allow the old tidegate to temporarily hold back tidewater during construction of the new structure (with temporary modifications), reducing implementation costs.

7.1.2 Task B: Restore an Estuary to Rocky Gulch

Estuaries are biologically highly productive environments characterized by high nutrient levels, brackish water, and diverse plant assemblages. In Rocky Gulch the historical estuary likely extended from the edge of Humboldt Bay across the entire bottomlands (the "diked former tidelands") now used as a pasture. The present elevation of the pasture suggests that, absent a tidegate or other controlling structure, mean-high-high water extends perhaps as far as station 23+00, near where the creek runs next to Old Arcata Road (Figure 18).

Despite extensive degradation and elimination of estuarine habitats along the entire Pacific coast, the research on anadromous salmonid life histories, habitat utilization, and habitat restoration has focused almost exclusively on freshwater habitats, while often overlooking the role of estuarine habitats. Past and recent research suggests that estuaries not only provide high quality rearing habitat for juvenile salmonids, but that estuarine rearing may significantly increase growth rates and contribute to a proportionally larger percentage of returning adults, compared to juveniles without access to estuarine habitats. Estuarine wetland restoration may be critical to restoring and sustaining anadromous salmonid populations.

The landowner on lower Rocky Gulch has agreed to allow a 3 acre section of the pasture along the north bank of lower Rocky Gulch (Figure 18 and 19) to be converted to estuarine wetland habitat. This restoration component is an important feature of habitat restoration in the Rocky Gulch bottoms, to be implemented in conjunction with the proposed tidegate design. This area is bordered by dikes on the north (Washington Gulch) and south side (Rocky Gulch), and extends upstream from the tidegate to approximately Stn. 16+00. Along the west boundary (Figure 18 and 19), a higher elevation area presently supports an extensive willow thicket, and will be preserved during restoration.

The targeted habitat condition in the restored estuary is classified by Cowardin (et al. 1973) as a "persistent, emergent wetland within an intertidal estuarine system", and would target supporting juvenile salmonids, waterfowl, birds, and small mammals. The ideal condition would be a regularly flooded brackish system comprised of tidal channels and mudflats with low salinities (ranging between approximately 1 to 10 ppt), sedge and cattail marsh areas, riparian hardwood species, and upland grasses.

Our preliminary conceptual design consists of excavating a braided network of tidal channels into the low elevation terrace area along the north-bank of Rocky Gulch (Figure 18 and 19), creating progressively smaller channels farther away from the main channel, which will generally drain back to the main channel as the tide recedes. Several of these side channels will terminate in small depressions that may retain water as the tide recedes. Excavated side channels in the upper marsh area will mimic abandoned "oxbow" channels, and will remain unconnected to the tidally influenced channel. I recommend placing large wood such as stumps and logs along the side-channel margins (preferably redwood and spruce), as habitat for rearing juvenile salmon. Wood structures in the channel can also create turbulent flow to erode and undercut banks, allowing natural processes to re-form and develop complex habitat.

This task may disturb some areas of relatively healthy habitat during implementation. However, the long-term benefits of restored tidal access to a broader area of land, and exclusion of cattle from this area, outweigh these short-term impacts. Additionally, there is a diverse assemblage and high abundance of plants in the surrounding area, which will help to recolonize disturbed areas.

7.1.3 Task C: Realign Lower Rocky Creek Channel to Reduce Confinement.

Presently Rocky Gulch is confined across the bottomlands between Old Arcata Road and poorly maintained dikes. These dikes are prone to overtopping, allowing floodwaters to flow into the

pasture, and eventually threaten fish stranding. The channel is completely straightened, and in several locations makes precise 90° corners. Presently, the entire creek corridor is only approximately 20 ft wide.

This task will treat the 1,600 ft section of channel that is straightened and most severely confined by dikes. This reach is directly upstream of the proposed estuarine area, and is dominated by freshwater runoff from the watershed, but with some tidal influence. I have proposed that the channel between stations 16+00 and 33+00 be relocated approximately 400 ft to the east to flow within a widened floodway corridor along the base of Old Arcata Road (Figure 19). The Rodoni's have agreed to allow the stream corridor to be widened to 100 ft. The berm along the left bank of the existing channel would be relocated along the new channel, but instead of confining the channel to a 20 ft corridor, it would instead provide up to 100 ft for a meandering channel, a floodplain, riparian vegetation within the stream corridor, and cattle exclusion from the stream corridor. There are numerous benefits to this proposed relocated channel, including:

- improved juvenile and adult salmon passage by reducing or eliminating flooding over top of the dikes during winter;
- improved hydrologic function of several tributaries that enter Rocky Gulch along Old Arcata Road (Halvorsen Gulch, Stevens Gulch, unnamed tributary) by allowing these tributaries to flow directly into Rocky Gulch, and potentially allowing fish access to eventually be restored to these creeks;
- improved salt marsh and wetland habitat quality by separating the creek and estuarine zones from the pasture, excluding grazing from these areas, which would in turn improve rearing habitat for juvenile salmon;
- improved pasture conditions by (1) reducing flooding and improving pasture drainage, (2) reducing salt water intrusion onto the pasture, (3) increasing the contiguous area of the pasture by relocating the channel bisecting the pasture, (4) improving freshwater drainage from pasture;
- reduced fill material needed for construction, by using Old Arcata Road as a dike to confine the Rocky Gulch channel to the east;
- reduced riparian fencing and potential cattle intrusion to only one side of the channel;
- improved vegetation cover and species diversity by preserving existing mature conifer cover;

7.1.4 Task D: Set Back Dikes Confining Rocky Gulch Along Old Arcata Road

The one-half mile stretch of Rocky Gulch along Old Arcata Road from Stn 33+00 to 55+00 is severely confined and degraded along this entire reach. The channel width is approximately 15–25 ft and is confined between Old Arcata Road and poorly maintained dikes (Figure 9), cattle access the creek in several locations, and moderate winter floods overtop the dikes in several locations (Figure 3). The landowner has agreed to allow the dikes to be pulled back away from the creek to create a creek corridor of at least 100 ft along this half-mile reach (Figure 19). This task will significantly improve the function of the creek by allowing the channel to migrate, providing a significantly larger storage volume for floodwaters during high winter streamflows, and by eliminating cattle intrusion into the stream corridor. This action will also improve the pasture condition by rehabilitating the dikes, thereby eliminating flooding onto the pasture. This rehabilitation action will benefit from the existing mature vegetation along the stream, which includes willow and alder understory, and a canopy primarily of redwood.

One unavoidable problem that arises with confined streams meandering across the diked former tidelands is fine sediment accumulation and eventual filling of the channel. Channel aggradation is a natural process in these lowland areas, as fine sediment is delivered from the watershed. Historically the channel naturally filled with fine sediment, built berms along the channel margins, then suddenly changed channel locations during large floods (channel avulsion), slowly and sporadically migrating across the entire valley bottom. Without the potential for the channel to migrate, these streams typically fill with fine sediment and become choked with vegetation. The best solution to this problem is to maintain the channel by periodically removing the fine sediment from the channel. This type of maintenance is already required and occasionally performed by the landowner in the present condition of Rocky Gulch. The landowner has requested that access to the stream channel be preserved to allow periodic maintenance. I propose access points be provided at regular intervals along this reach to allow the landowner access to the channel to occasionally remove accumulated fine sediments. These sediment removal sites would resemble pools in the channel (available for adult salmon holding), designed primarily to function as small sediment ponds that slowly accumulate fine sediment until the pool "fills" and sediment removal is required. In this way the long-term integrity of the stream corridor is maintained.

7.2 Phase II: Old Arcata Road (tasks E-H)

7.2.1 Task E: Channel Rehabilitation at Old Williamson Ranch

The first 500 ft of Rocky Gulch channel downstream of Old Arcata Road is a broad "U" shaped bend around the old Williamson Ranch residence. There is adequate slope and good quality gravel through this reach to provide spawning habitat for coho salmon, but minor improvements in this reach will considerably improve the quality of salmonid habitat. The channel through this reach has been mowed in the past to prevent riparian vegetation from establishing along the banks, and to keep the channel clear of obstructions. A former resident also placed two small concrete culverts in the channel to provide a stream crossing from house to garage for vehicle and/or foot traffic (Figure 22). I recommend the culverts be removed and replaced with a bridge. In addition to improving the channel, this change will also reduce the threat of flooding caused by a backwater effect from undersized culverts. I also suggest that vegetation be allowed to establish along the stream banks to provide overhead cover and maintain bank stability. Periodic vegetation maintenance may be required to prevent the channel from becoming choked by encroaching willow and alder, which is a common problem of low-lying creek channels. The present landowner has agreed to implement both these recommendations, potentially with some funding assistance from CDFG for a small foot-bridge.

7.2.2 Task F: Old Arcata Road Culvert Replacement

The Old Arcata Road culvert (Figure 19), while presently allowing adult salmonid passage, is nevertheless a problem that needs to be addressed. As mentioned, the culvert is undersized and causes periodic flooding of the upstream parcel. The stream banks on the upstream south side of the channel are also unstable, and the wooden retaining wall structure installed by the landowner is collapsing and in need of permanent repair. I recommend the culvert be replaced with the structure designed by Humboldt County and their consulting engineers (Appendix A).

7.2.3 Task G: Barrier Culvert

There exists at least 2,200 ft of high quality salmonid habitat upstream of the barrier culvert that is presently inaccessible to coho salmon and steelhead. This habitat has been recovering since the mid-1960's and, together with the downstream habitat, there appears abundant habitat suitable to sustain at least 50-100 coho spawners. The design options for the barrier culvert (Appendix B) include (1) replacing the existing 4 ft pipe culvert with an enlarged, partially embedded culvert, (2) constructing an arched culvert with natural streambed, or (3) installing a bridge crossing. Because of the length

of time the existing structure has been in place, the elevation drop through the culvert is substantial (Figure 23) and grade control structures will be required to prevent unwanted erosion of the channel thalweg (headcutting). This type of channel stabilization is common in culvert replacement projects, and is typically constructed to look natural by using boulders and large wood pieces. The overall cost of the project is substantial, and should not be undertaken until restoration is completed to allow unobstructed fish passage through downstream reaches. Once migratory access past the upstream barrier culvert is eventually restored, however, the benefits to anadromous salmonids will be enormous.

7.2.4 Task H: Stream Channel Rehabilitation

Upstream of the barrier culvert the channel is presently overly-confined, likely a remnant of the timber mill operations that once existed along this reach. The channel is as narrow as 7–10 ft and entrenched up to 6 ft deep in several locations for approximately 200 ft upstream of the culvert. The confinement has reduced or eliminated most salmonid habitat and slowed the rate of stream recovery in this reach. I recommend this section of stream be rehabilitated during the culvert replacement project. This task will therefore extend the culvert/channel work upstream to widen the channel and reduce confinement. This work will benefit the culvert project by allowing grade control structures to be placed farther upstream. The grade control structures (boulders and logs) will also improve salmonid habitat in this reach.

7.3 Phase III: Preservation and Monitoring

7.3.1 Barrier Culvert to Headwaters Preservation

This section of Rocky Gulch is in relatively healthy condition. Our primary recommendation, no less important than other restoration actions, is to *preserve* this healthy habitat for eventual recolonization by coho salmon and steelhead. Undisturbed, high quality salmonid habitat such as this in the north Humboldt Bay region is rare, and should be protected against the impacts common to most other small watersheds, including rural residential over-development, and excessive timber harvest.

7.3.2 Monitoring

This project provides the opportunity to recover coho salmon and steelhead to an entire watershed. Stream restoration projects with the potential to recover entire populations to a watershed where they have been denied access for decades, are indeed rare. Obviously, attempting to re-create habitats, particularly estuarine conditions controlled by a man-made tidegate structure, is experimental. These project components should therefore be studied to document their effectiveness in achieving the stated project goals.

I recommend several monitoring components during and following project implementation. To maintain reasonable implementation costs, I recommend that monitoring be funded during Phases II and III of restoration, following rehabilitation of the bottoms and removal of upstream fish passage barriers. Monitoring should include:

Monitor fish passage at the tidegate. The first and most important monitoring component will be to confirm that fish are able to effectively pass through the new tidegate. This may be difficult to observe due to water turbidities. Monitoring may have to rely on anecdotal evidence and inference to determine fish passage, i.e., by observing adult salmonids migrating and spawning upstream. Other potential (but expensive) methods could include employing pit tags and detectors installed across the tidegate structure to document fish passage.

Monitor salinity, temperature, DO, nutrient conditions, and primary/secondary production at the estuary. The function and productivity of the newly restored estuary will be important conditions determining the effectiveness of this restoration project and the potential contribution to habitat for

anadromous salmonids. Estuarine rearing is critical to juvenile salmonids, and much more needs to be learned about this life stage, particularly for coho salmon. Rocky Gulch offers an ideal situation for this type of monitoring and experimentation because all the conditions will be newly created, and the restored fish population will have benefited only from this restoration project.

Monitor vegetation recovery within the tidally influenced estuary and along the riparian corridor. Because of the presence of cattle in the surrounding pasture, it will be important to observe the recovery of the revegetated and newly excluded areas. There is great potential for regeneration of a broad diversity of flora, including salt marsh and freshwater wetland vegetation, obligate riparian species, and conifer species.

Monitor fish population recovery upstream of Old Arcata Road. Recovery of fish populations within this section of stream is the primary goal of this project, and should be studied. This monitoring should include (a) spawning surveys (redd surveys and carcass counts) to estimate species composition and size of the populations; (b) quality of spawning gravels to estimate the potential egg survival-to-emergence; (c) rearing habitat availability and use, including estimates of growth rates of rearing salmonids; (d) juvenile migration (both upstream and downstream) and use of the estuary for rearing and smoltification; (e) estimates of the rate of return as adults of salmon using different rearing strategies and exhibiting differential juvenile growth rates.

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9 APPENDICES

Appendix A: Old Arcata Road Culvert design

Appendix B: Barrier Culvert design

Appendix C: Watershed Overview Work Sheet

Table 1. Flood Frequency data for streams in the vicinity of North Humboldt Bay, and Rocky Gulch flood frequency estimates prepared for the Old Arcata Road Culvert replacement project.

								100-year Peak Discharge from Log-Pearson-III		
Station Number	Stream Name	Record Length (years)	Coverage (WY)	Drainage Area (sq. miles)	MAP (in/yr)	**Qave (cfs)**	**Qave/DA**	$Q_{100\text{-yr}}/Q_{ave}$ (cfs/cfs)	for Morrison Gulch Adjusted by Qave (cfs)	for Morrison Gulch Adjusted by DA ratio (cfs)
11479700	Elk R. Nr Falk	10	1958-67	44.20	55	**104.1**	**2.4**	41.4	**66.3**	**96.6**
11480000	Jacoby C Nr Freshwater	19	1958-67	5.80	65	**17.9**	**3.1**	186.1	**297.7**	**569.6**
11480800	NF Mad R. Nr Korbel	9	1958-64 1973-74	40.40	68	**124.9**	**3.1**	144.6	**231.3**	**442.5**
11481200	Little River Nr Trinidad	43	1953-98	40.50	70	**137.2**	**3.4**	105.5	**168.9**	**353.8**
	Morrison Gulch	2	1999-00	0.99	45	**1.60**	**1.6**	-	**-**	**-**
								Waananen and Crippen	**Rational Method**	**Log Pearson III (based on Jacoby Creek)**
	Rocky Gulch (Q100-yr)	1	2002	1.13	39.8	2.5	**2.2**	344	**378**	**950**
	Rocky Gulch (Q100-yr/Qave)							138	**151**	**380**

Table 2. Habitat mapping data for Rocky Gulch for the reaches upstream of Old Arcata Road. This section of stream was mapping during two different surveys, both at similar streamflow conditions. Major features along the stream are highlighted in gray.

Habitat Unit No.	Habitat Unit Type	Station (ft from OAR)	Station (ft) from Humboldt Bay	Unit Length	Mean depth	Max Depth	NOTES
1	Mid-Channel Pool	0	6000	50	0.8	2	Starting at Old Arcata Road Culvert
2	Cascade	50	6050	5	1.2		
3	Mid-Channel Pool	55	6055	29			
4	Low Gradient Riffle	84	6084	4			Small woody debris and mud jam. Passable
5	Mid-Channel Pool	88	6088	22			
6	Low Gradient Riffle	110	6110	299			Station 150 is start of Sway property
7	Cascade	409	6409	11			
8	step-pool	420	6420	39			
9	Run	459	6459	17			
10	Mid-Channel Pool	476	6476	39	0.8	1.5	
11	Low Gradient Riffle	515	6515	14			Station 515 is start of Scharnberg property
12	Run	529	6529	26		1.2	
13	Low Gradient Riffle	555	6555	44			
14	Corner Pool	599	6599	14	1.5	2.2	
15	Low Gradient Riffle	613	6613	76			
16	Medium Grade Riffle	689	6689	44		1.2	
17	Corner Pool	733	6733	19		1.7	
18	Low Gradient Riffle	752	6752	166	0.4	0.8	Stn 791 40 ft long culvert, 5ft diam, 1.5 ft substr depth, low gradient; Passage OK;
19	Cascade	918	6918	7	1.4	2.6	
20	Step Pool	925	6925	75			
21	Lateral Scour Pool Root Wad	1000	7000	15	1	1.4	Stn 1,000 start Lot-4 property line
22	Low Gradient Riffle	1015	7015	176	0.6	1	
23	Lateral Scour Pool Root Wad	1191	7191	19	1.3		
24	Low Gradient Riffle	1210	7210	90			
25	Mid-Channel Pool	1300	7300	30			Stn 1,300 approx start of Mierau property
26	High Gradient Riffle	1330	7330	21			
27	Low Gradient Riffle	1351	7351	19	0.8	1	
28	Mid-Channel Pool	1370	7370	25		1	
29	Medium Grade Riffle	1395	7395	32			
30	**Plunge Pool**	1427	7427	23	1	1.3	Study Reach Pool; pressure transducer and staff plate
31	Low Gradient Riffle	1450	7450	36			
32	High Gradient Riffle	1486	7486	6			
33	Low Gradient Riffle	1492	7492	13			
34	Plunge Pool	1505	7505	5		1.5	
35	Low Gradient Riffle	1510	7510	20			
36	Mid-Channel Pool	1530	7530	12		1.2	
37	Low Gradient Riffle	1542	7542	18			
38	Lateral Scour Pool Log	1560	7560	15		1.8	
39	Low Gradient Riffle	1575	7575	92			
40	Plunge Pool	1667	7667	20	3	4.2	
41	**Culvert**	1687	7687	60			Stn 1687 is 60 ft long, 4 ft diam culvert; 5ft water fall from bottom culvert to WSEL; NO PASSAGE
42	Medium Grade Riffle	1747	7747	27	0.5	0.7	
43	Plunge Pool	1774	7774	16		1.6	Plunge pool from skid road across channel
44	Low Gradient Riffle	1790	7790	56			
45	Unknown	1846	7846	100			Impenatrable channel area; 100 ft length estimated; highly confined
46	Mid-Channel Pool	1946	7946	12	0.8	1.2	At Stn 1900 Water Main Pipe "Kennedy Valve Mfg Co. 1952"
47	Low Gradient Riffle	1958	7958	16	0.3		Stn 1946 is END Mierau property

Table 2.. Continued

Habitat Unit No.	Habitat Unit Type	Station (ft from OAR)	Station (ft) from Humboldt Bay	Unit Length	Mean depth	Max Depth	NOTES
48	High Gradient Riffle	1974	7974	7			
49	Corner Pool	1981	7981	7	0.4	0.7	
50	Medium Grade Riffle	1988	7988	31			Potential Study Reach location
51	Lateral Scour Pool Rood Wad	2019	8019	11	0.4	0.8	
52	Medium Grade Riffle	2030	8030	77	0.5	1.2	
53	Mid-Channel Pool	2107	8107	14			
54	Low Gradient Riffle	2121	8121	14			
55	Glide	2135	8135	15	0.3	0.5	
56	Low Gradient Riffle	2150	8150	49	0.2		
57	Mid-Channel Pool	2199	8199	26	0.6	1	
58	Low Gradient Riffle	2225	8225	19			Stn 292 first appearance of bedrock
59	Lateral Scour Pool Boulder	2244	8244	18	0.6	1	
60	Medium Grade Riffle	2262	8262	14			
61	Corner Pool	2276	8276	20	0.4	0.8	
62	Low Gradient Riffle	2296	8296	8			
63	Mid-Channel Pool	2304	8304	17	0.4	1	
64	Low Gradient Riffle	2321	8321	53			
65	Mid-Channel Pool	2374	8374	18	0.6	0.9	
66	Low Gradient Riffle	2392	8392	6			
67	Glide	2398	8398	13			
68	High Gradient Riffle	2411	8411	9			
69	Mid-Channel Pool	2420	8420	15	0.4	0.7	
70	Medium Grade Riffle	2435	8435	150			Stn 490 large alder trunks across channel; More LWD up here;
71	Cascade	2585	8585	9			
72	Plunge Pool	2594	8594	69	1	1.2	
73	Medium Gradient Riffle	2663	8663	43			
74	Medium Grade Riffle	2706	8706	18			
75	High Gradient Riffle	2724	8724	22			
76	Medium Gradient Riffle	2746	8746	120			
77	Plunge Pool	2866	8866	20	---	2.5	
78	Low Gradient Riffle	2886	8886	8			
79	Mid-Channel Pool	2894	8894	8	0.8	1	
80	Low Gradient Riffle	2902	8902	71			
81	Lateral Scour Pool Log	2973	8973	196			
82	Plunge Pool	3169	9169	302			
83	**Cascade**	3471	9471	23			one 4 ft elev drop, difficult passage. Possible end of upstream anadromous migration;
84	Medium Gradient Riffle	3494	9494	157			
85	Plunge Pool	3651	9651	10			Plunge pool at small culvert outfall
86	CULVERT	3661	9661	39			Culvert. 4 ft diam, 40 ft long; low gradient, 1.6 ft from bottom culvert to WSEL. GOOD PASSAGE;
87	Medium Gradient Riffle	3700	9700	122			
88	Plunge Pool	3822	9822	86			Log Weir plunge pool
89	Plunge Pool	3908	9908	13			Birthday Pool
90	**Cascade**	3921	9921				Cascade Complex; 4ft gradient change; passage questionable. Possible end of upstream anadromous migration;
91	Pond	4066	10066				Off-Channel pond next to road for sediment control from Quarry
92	Start of Hard Rock Quarry	4346	10346				
93	**End Hard Rock Quarry**	4696	10696				End survey at Rock Quarry

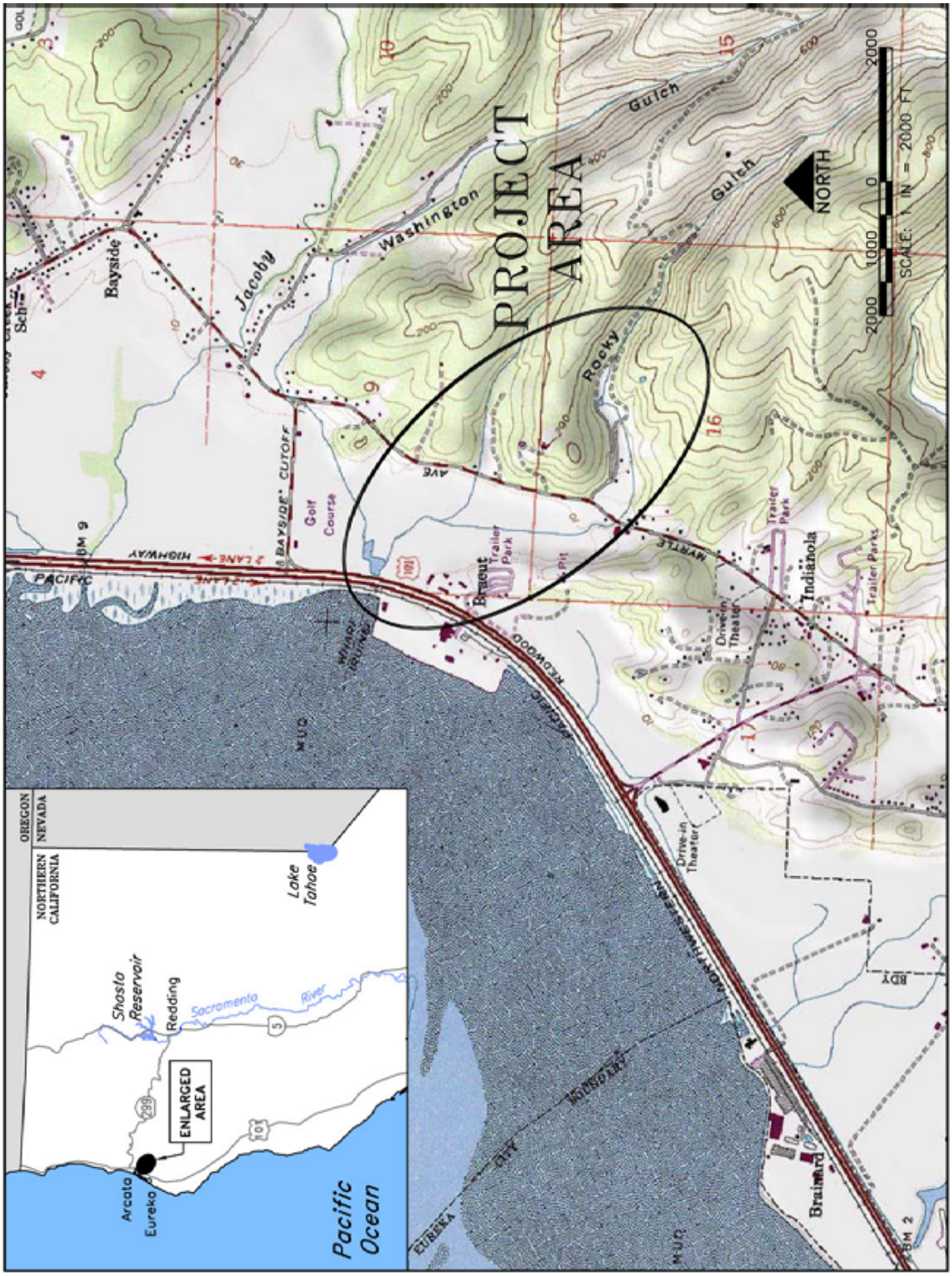


Figure 1. USGS 7.5' Quad Map showing the location of Rocky Gulch, Humboldt County, CA., and the project area. The stream does not follow the same course across the Bottoms as indicated in the topo map, but instead has been partially realigned along Old Arcata Road.

Figure 2. Historical photos (ca. 1960) from Department of Fish and Game files showing Rocky Gulch logging operations that caused a large debris slide and heavy sedimentation of the stream in 1957.

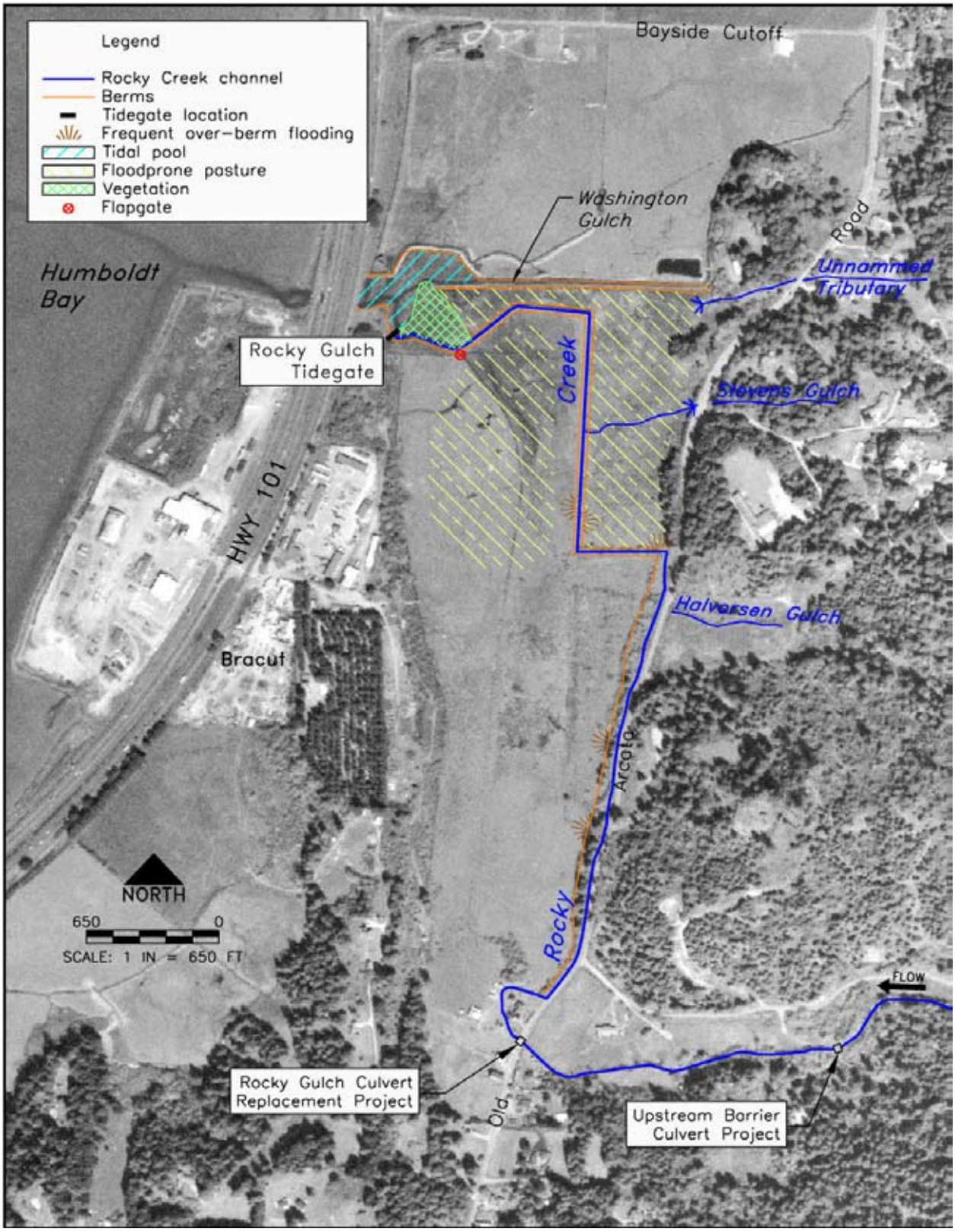


Figure 3. Rocky Gulch bottoms EXISTING CONDITIONS showing a heavily confined and straightened channel. This channelized condition, along with poor connectivity to tributary channels, contributes to poor passage conditions for anadromous salmonids, flooding of the pasture, and runoff of pasture "nutrients" into the channel and Humboldt Bay.

Figure 4. Rocky Gulch at Stn 95+00. There are approximately 1.5 miles of habitat upstream of Old Arcata Road with conditions similar to this photo, that would provide ideal conditions for coho salmon and steelhead once the major migratory barriers are removed.

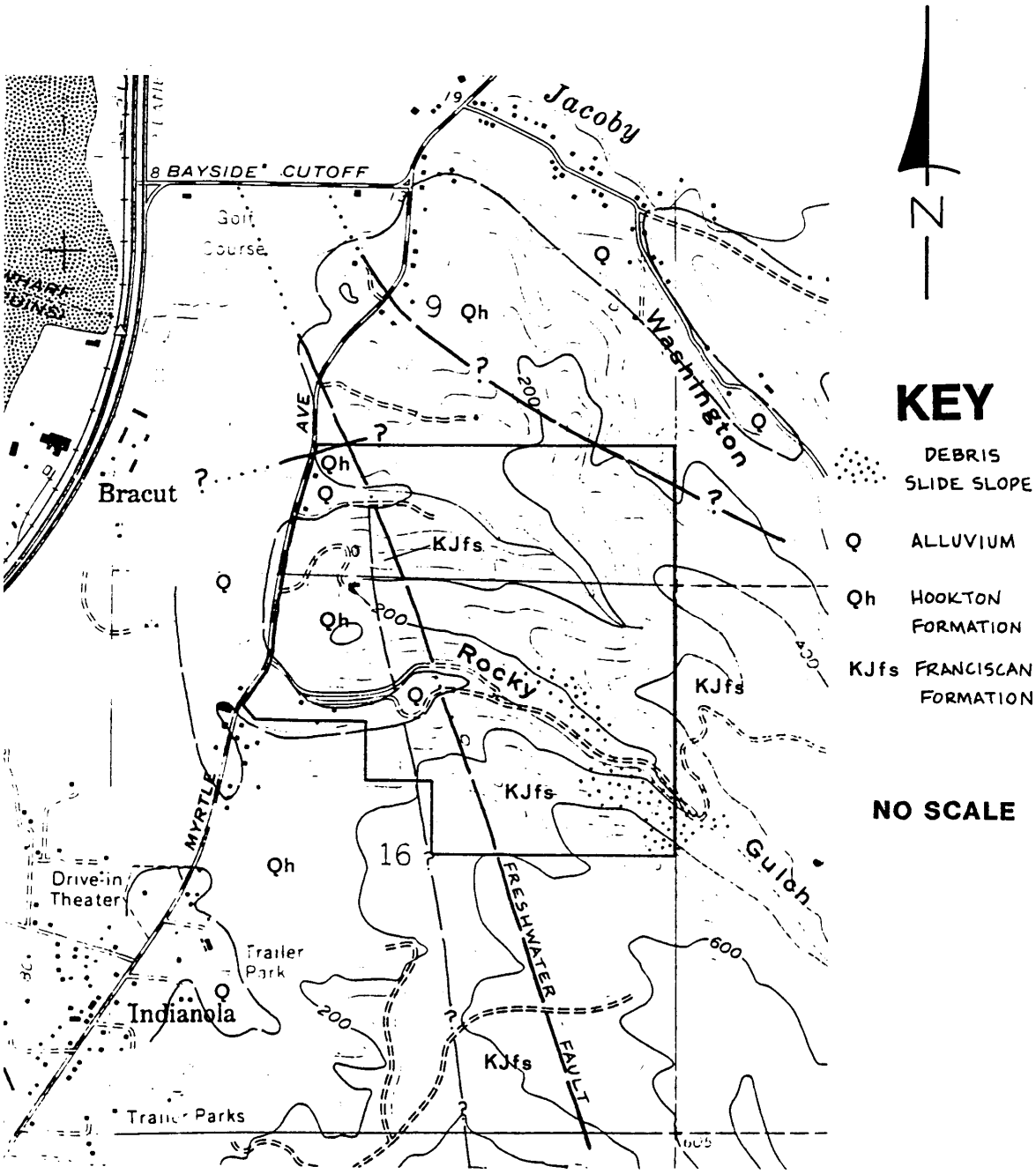


Figure 5. Geologic map of the Rocky Gulch watershed

Figure 6. Rocky Gulch tidal pool, located just to the east of Hwy 101, shown at low tide, flowing into the Hwy 101 culvert. The high tide level just inundates the concrete culvert abutments.

Figure 7. Rocky Gulch tidegate at Stn 6+00, during a receding tide when flow is partially opening the tidegate. Photo A (above) shows view looking upstream on the seaward side of the tidegate. The structure on the left is abandoned and plugged. Photo B (below) is the view looking down on the tidegate. Note no passable space between the sides of the gate and the old concrete wing-walls.

Figure 8. Photo A (above): Lower Rocky Gulch Bottoms looking downstream from Stn 13+00 at a moderate tide elevation. The pasture to the left of the berm is frequently inundated during winter. The grassy area to the right of the channel is the area proposed to be restored to estuary. Photo B (below) shows a single existing side channel that meanders through the proposed estuary area. Task B would create more side channel habitat similar to this, to provide brackish water rearing for salmonids.

Figure 9. Upper Rocky Gulch Bottoms. Photo A (above) shows the straightened, channelized reach at Stn 22+00, with heavy vegetation growing in the channel. Photo B (below) at Stn 55+00 shows the creek along Old Arcata Road, narrowly confined between the road and dike, with total stream corridor width of approximately 10-15 ft.

Figure 10. Rocky Gulch at Stn 75+00, approximately 1400 ft upstream of Old Arcata Road and 300 ft downstream of the Barrier Culvert. The pool in the distance under the downed redwood trunk has undercut banks, maximum depths of over 2.0 ft, and a pool tail with adequate gravel size for coho spawning. Photo taken at a low winter baseflow of approximately 2 cfs.

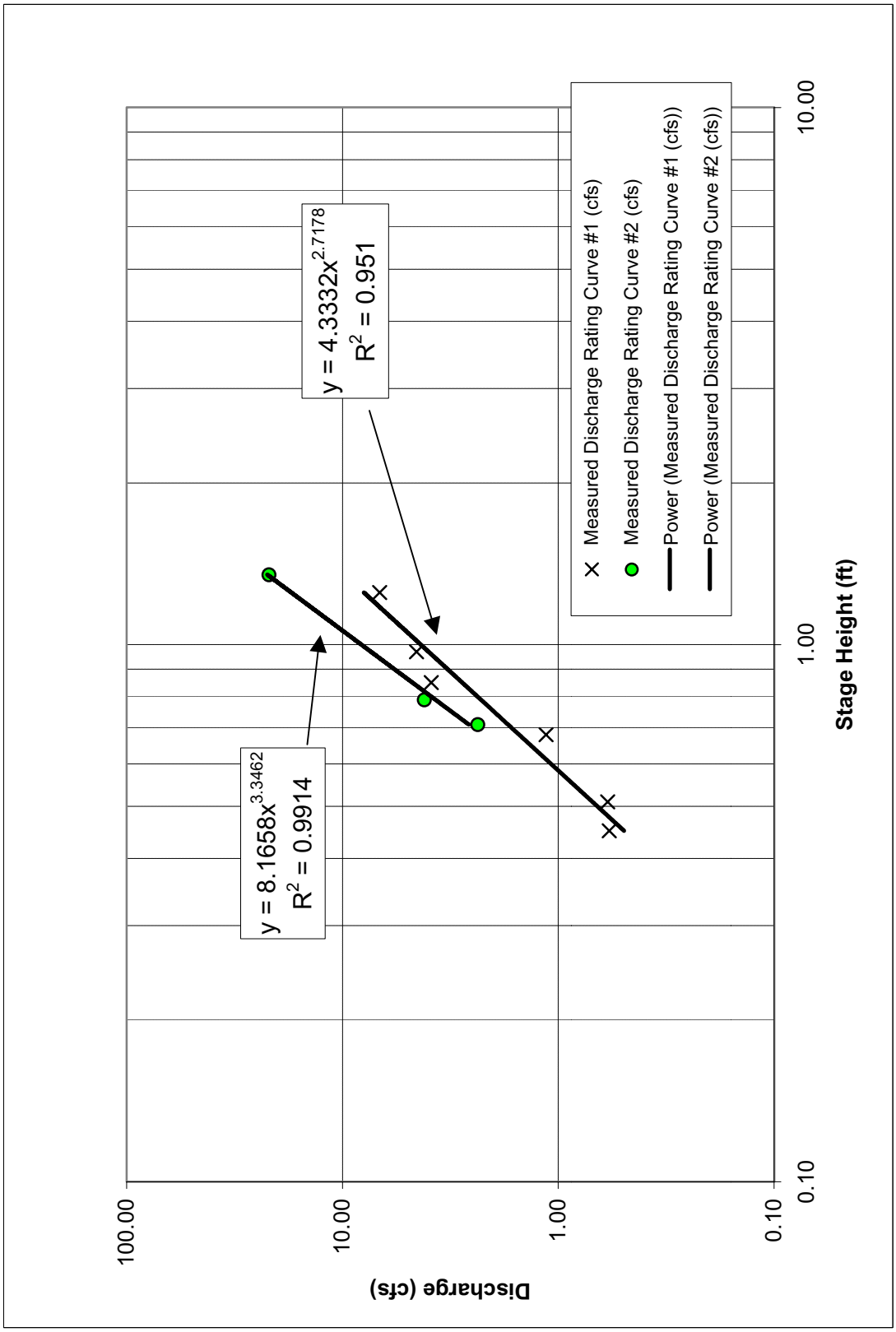


Figure 11. Rating curves developed for Rocky Gulch stream gage. High flows on 12/5/01 buried the staff plate and pressure transducer, requiring they be relocated and a new rating curve be developed.

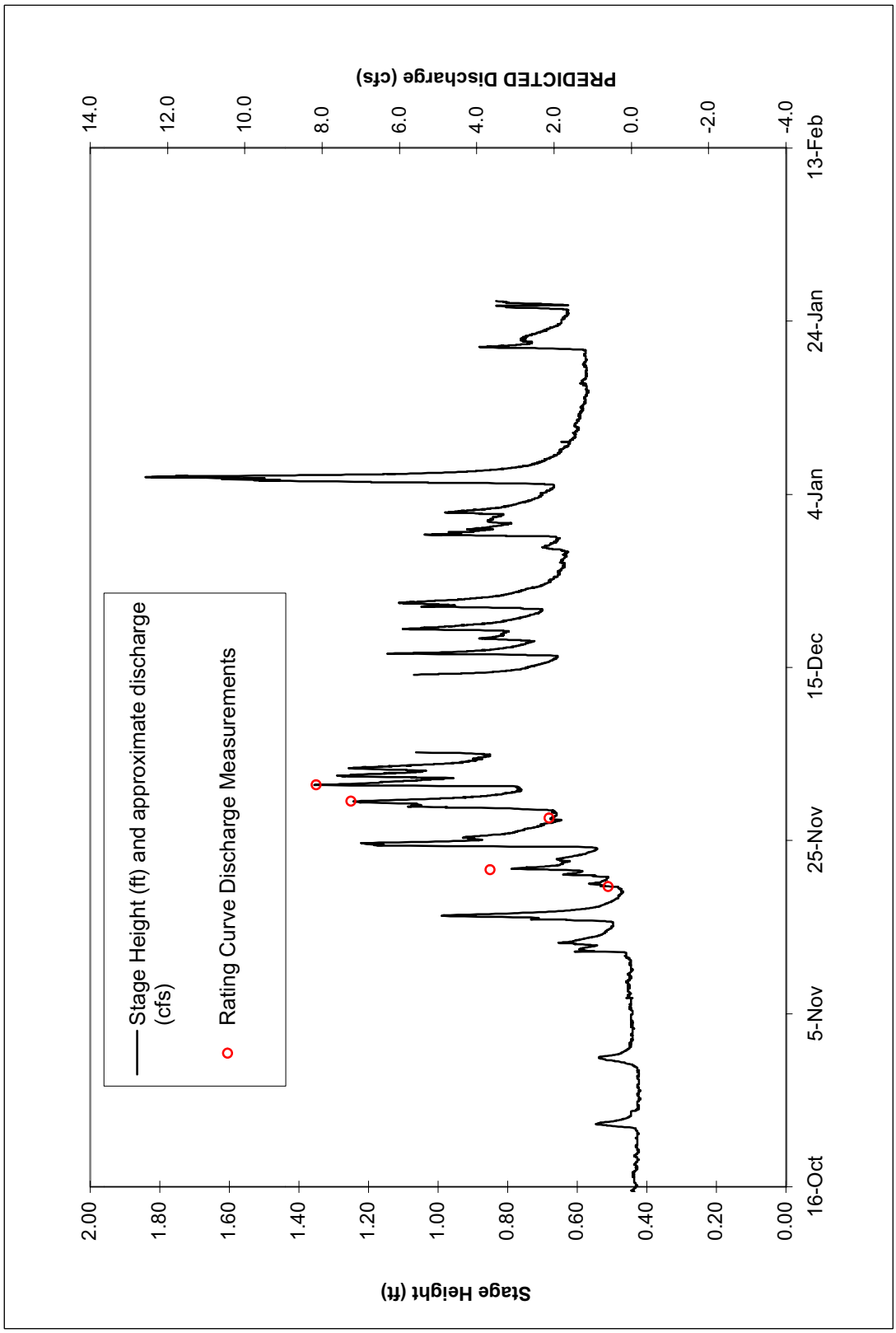


Figure 12. Hydrograph of daily average flow for Rocky Gulch developed from the stream gage installed at station 75+00. The gap in the data corresponds to the period of time the gage was down following a large storm that buried the pressure transducer.

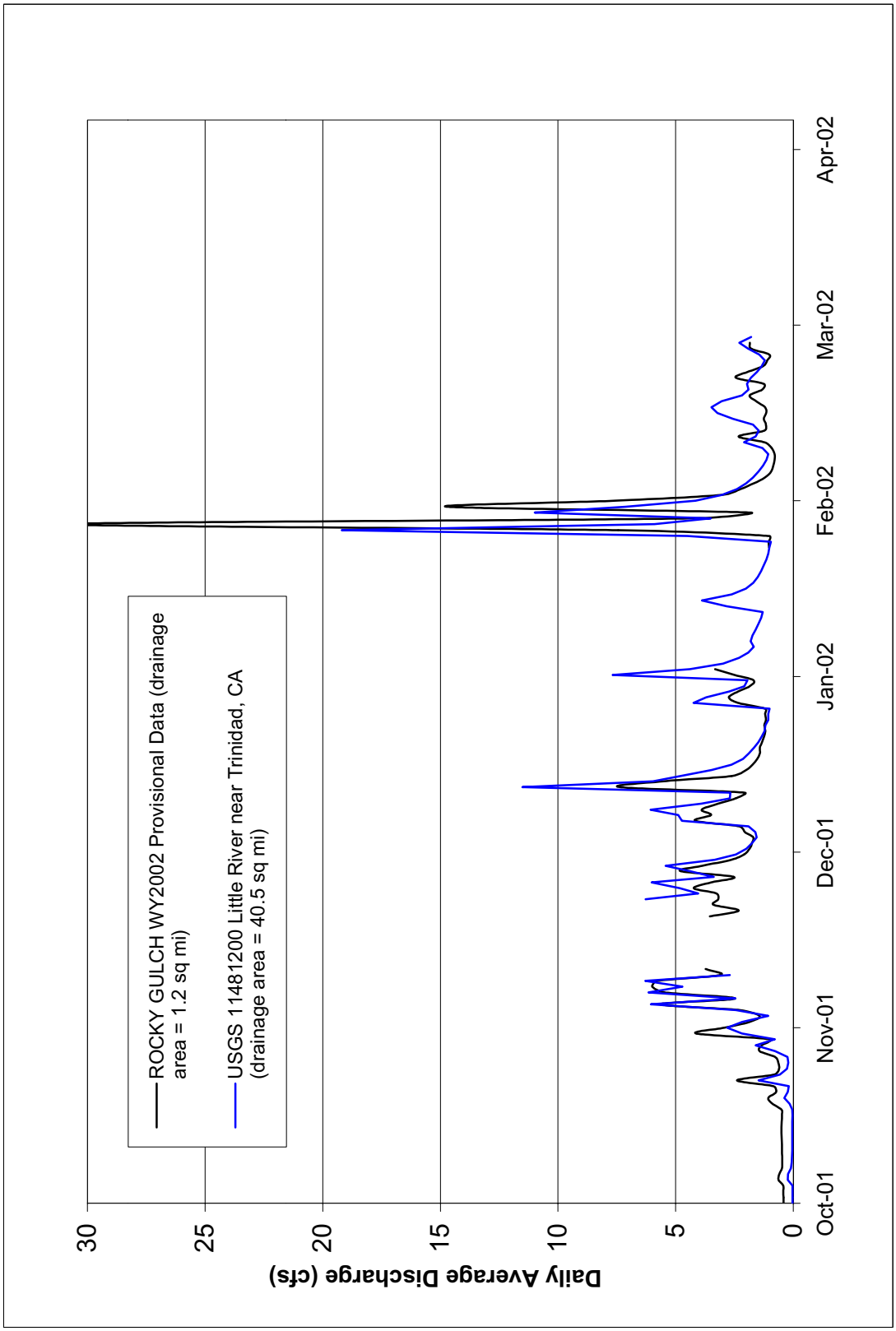


Figure 13. Daily average hydrographs for Little River near Trinidad (USGS Gage) and Rocky Gulch prediced discharge, with Little River data adjusted to fit the Rocky Gulch data.

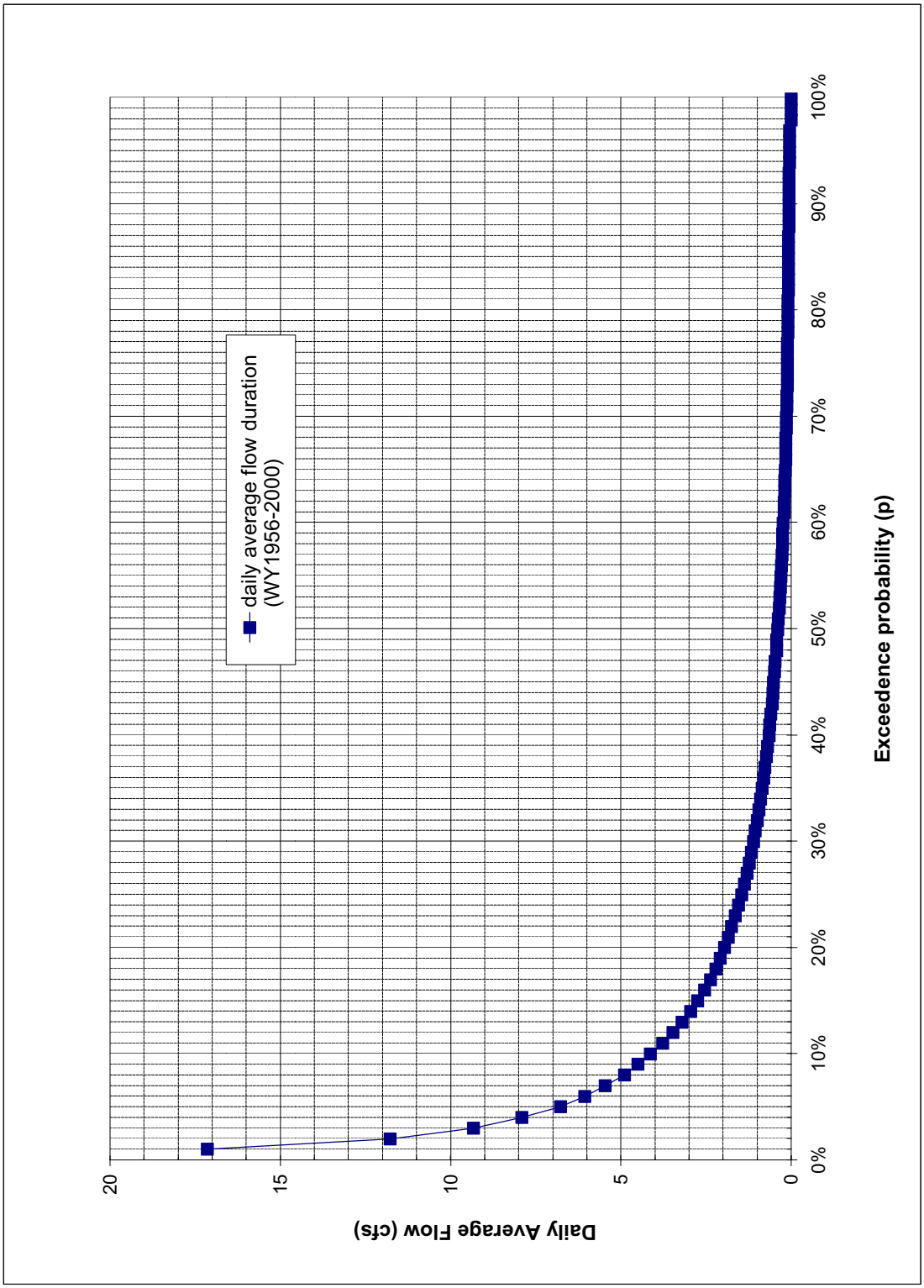


Figure 14. Daily average flow duration curve for Rocky Gulch, based on Little River near Trinidad period of record.

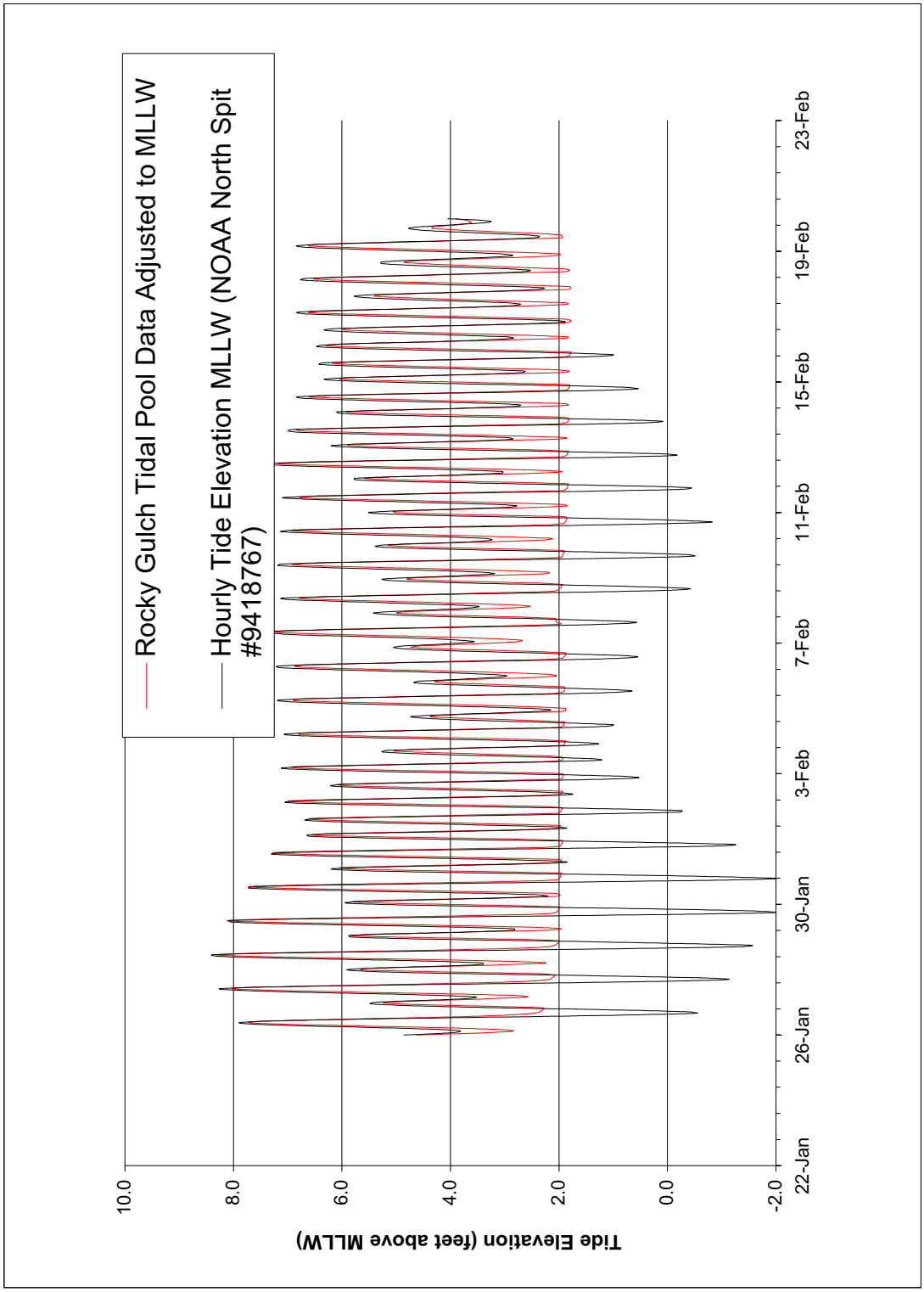


Figure 15. Comparison of tide stage data for Rocky Gulch at the tidegate and the NOAA North Spit station. The Rocky Gulch tidal pool does not drop below approximately 2.0 ft elevation because the culvert allows tide water to pool up upstream of the Hwy-101 culvert at low tides.

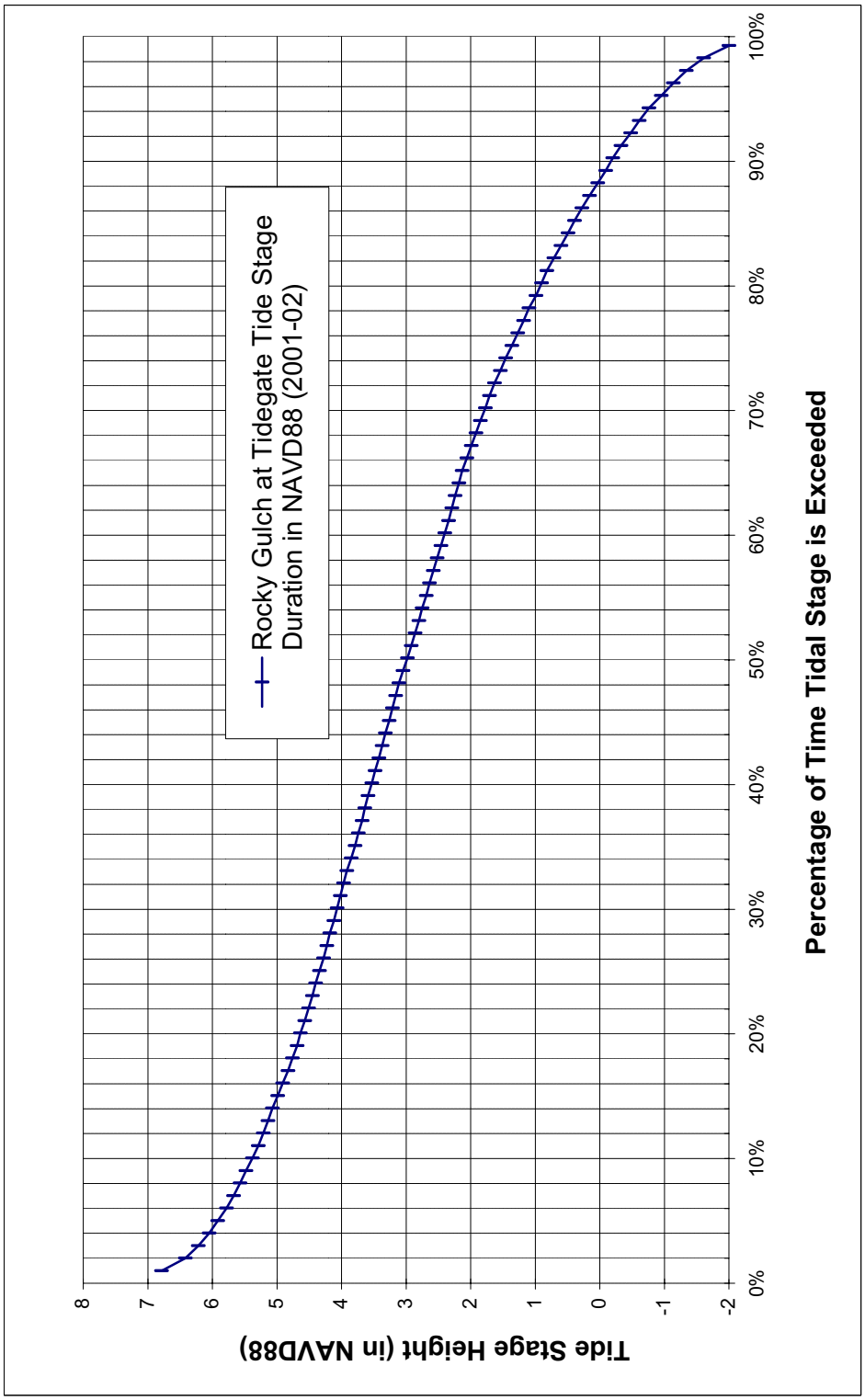


Figure 16. Tide-stage duration curve for Rocky Gulch at the tidegate. This chart allows calculation of the duration of time the tide exceeds a specified stage elevation, which can be used to adjust the height of the notched weir sill in the proposed tidegate design.

Figure 17. Rocky Gulch Culvert at Old Arcata Road. This culvert is planned to be replaced by Humboldt County Public Works Department as part of Old Arcata Road rehabilitation work scheduled for 2003. No funding is requested for this project in this proposal.

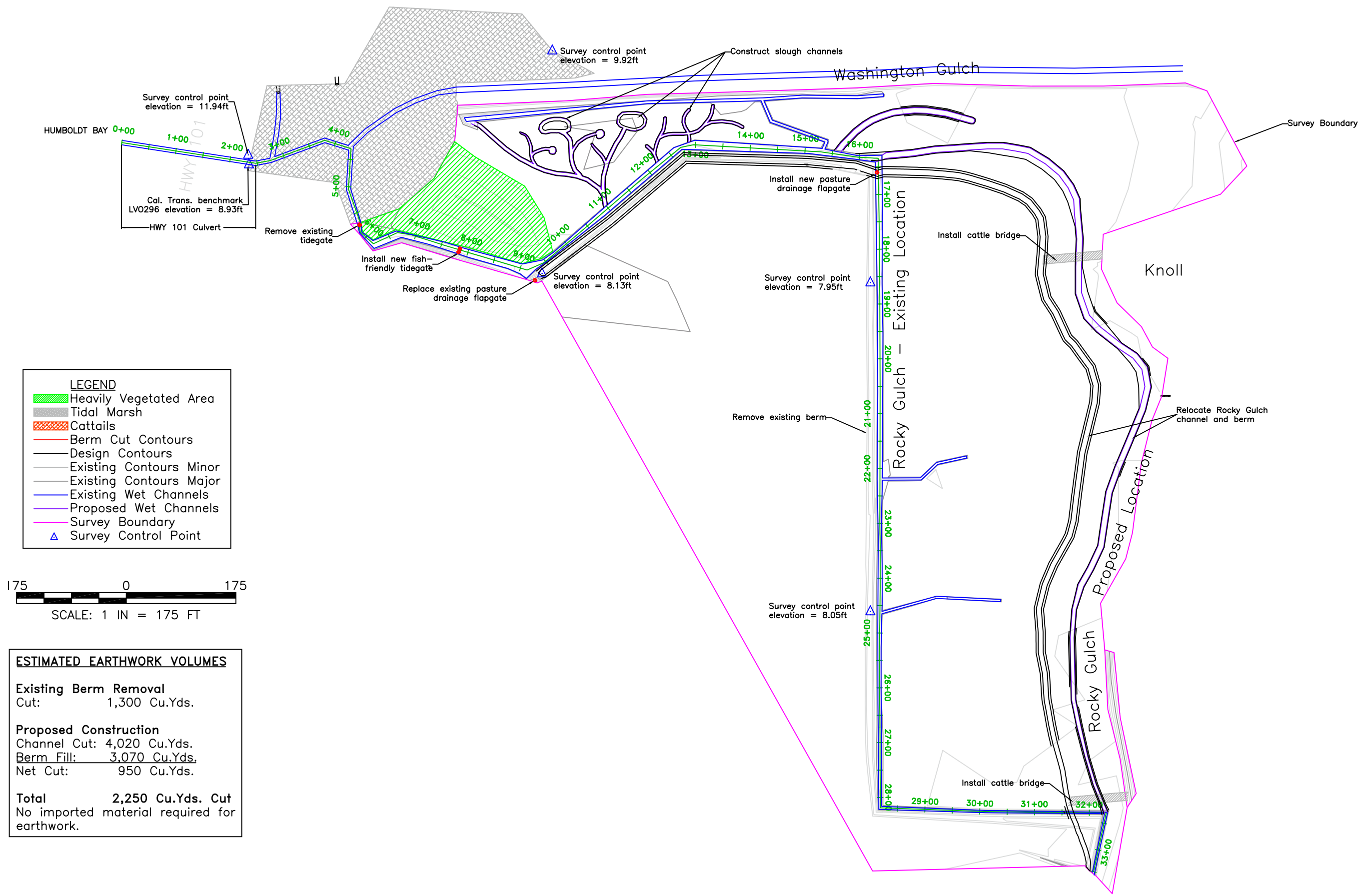


Figure 18. Existing conditions and proposed restoration designs in the Rocky Gulch bottoms.

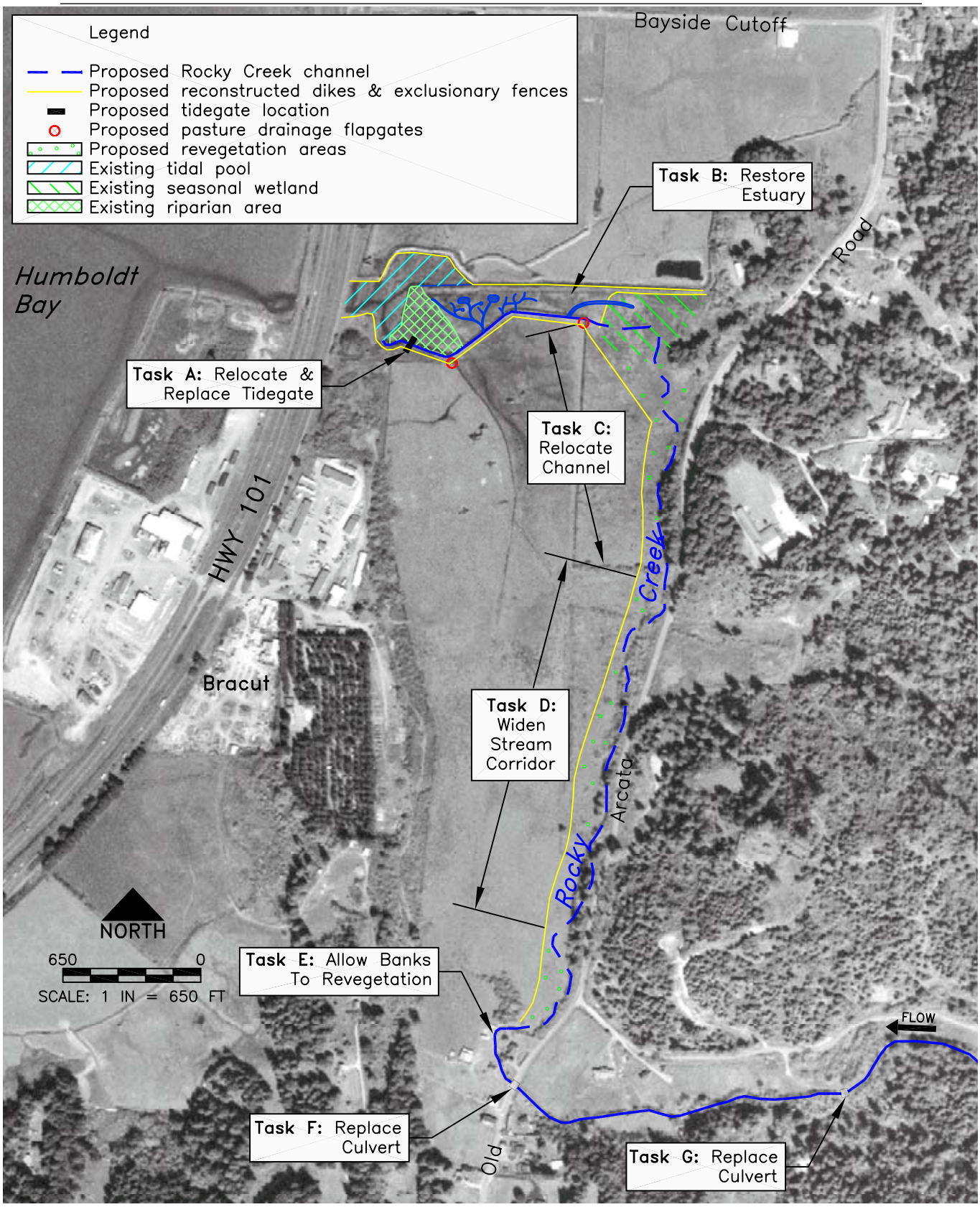


Figure 19. Major components proposed to restore anadromous salmonid access to Rocky Gulch. These tasks are recommended to be implemented in two phases. Completion of Phase I channel rehabilitation tasks will allow fish to migrate upstream to the barrier culvert at the bottom right of this photo. Completion of Phase II culvert replacements will allow fish to access an additional nearly 4,000 ft of high quality salmonid habitat

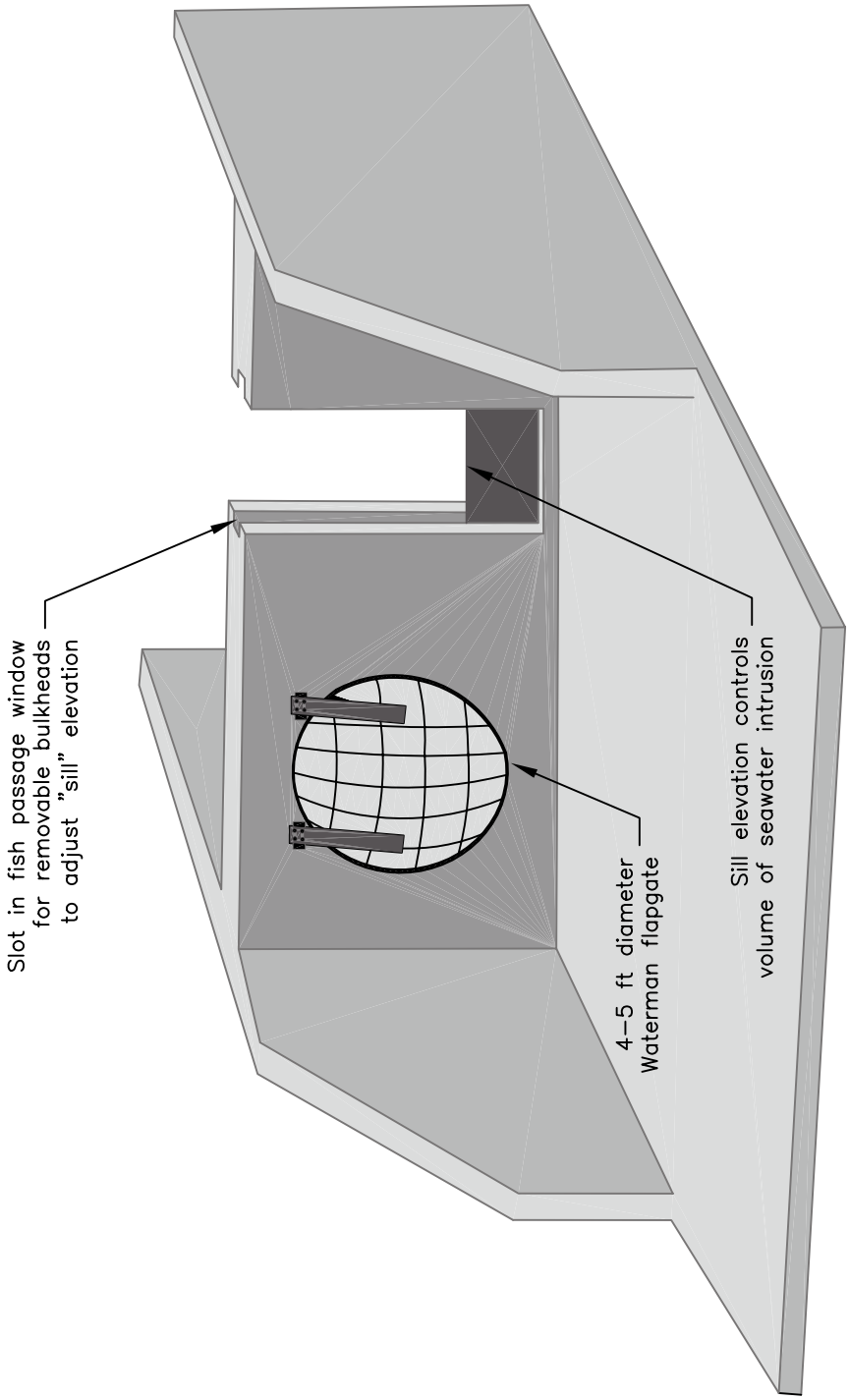


Figure 20. Proposed conceptual design for a new tidegate for Rocky Gulch. This design includes a notched weir with removable bulkheads to allow the sill elevation to be adjusted. The height of this sill will ultimately control the volume of seawater allowed to pass the tidegate. The conventional flapgate will allow rapid outflow of tidewater and Rocky Gulch streamflow.

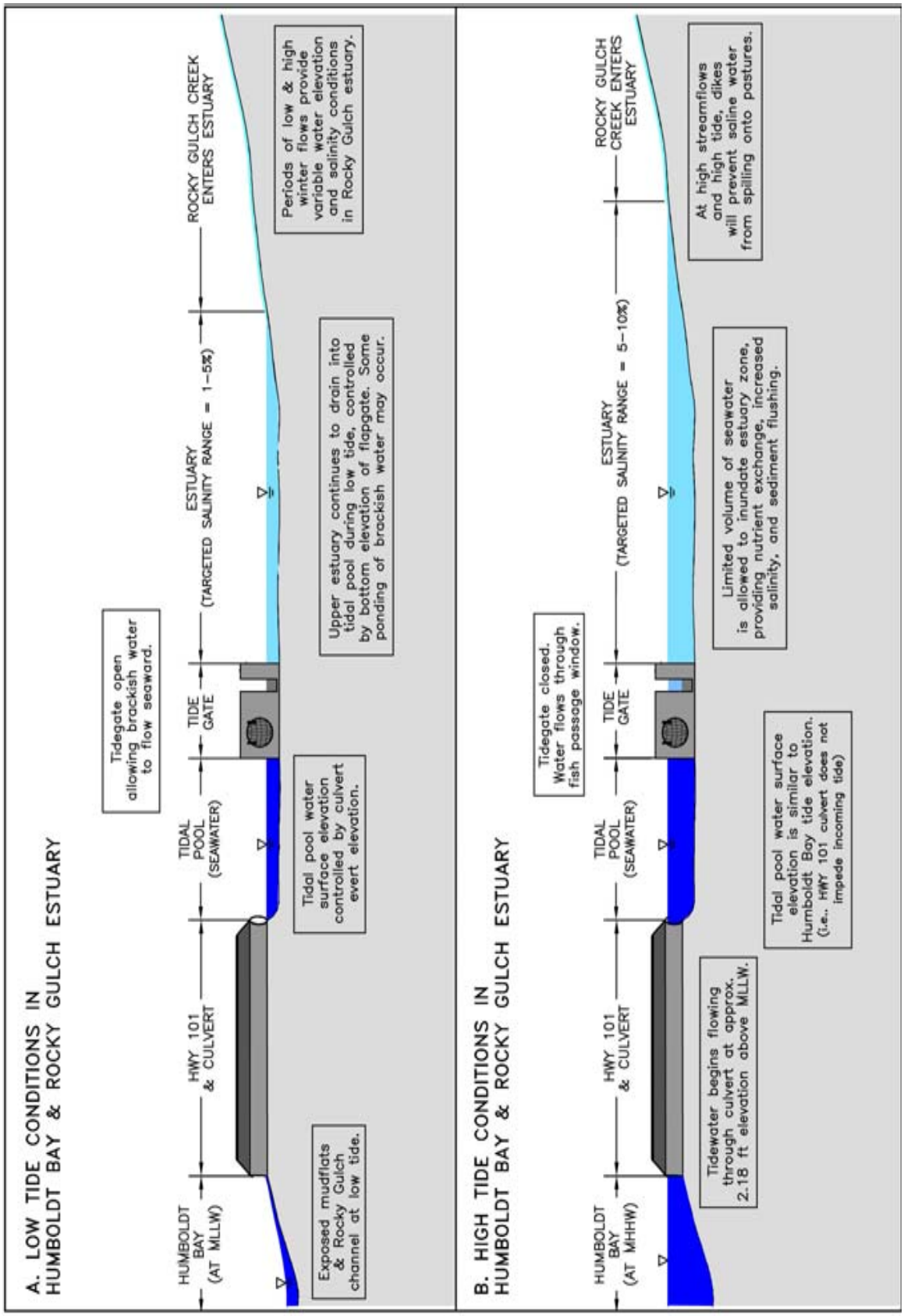


Figure 21 Conceptual illustration showing the proposed tidal pool, tidegate, and estuary at low tide and high tide conditions. The Hwy 101 culvert does not control tidal flow so the tidal pool would be high salinity. The proposed tidegate would allow only a limited volume of tidewater to pass, enough to allow free fish movement through the fish passage "window". We would target low salinities in the restored estuary, in the range of 1-10 ppt.

Figure 22. Culverts placed by a former owner of this residential site are undersized, unnecessary, and should be removed. The current property owners support replacing these culverts, and are also willing to allow vegetation to regenerate along the stream banks.

Figure 23. Barrier culvert at Stn 77+00 on Rocky Gulch. Preliminary engineering designs were prepared with funding from the existing Rocky Gulch Stream Assessment Project (CDFG Contract No. P0010372) to replace this culvert with a structure that allows fish to access the additional mile of prime habitat upstream. A separate funding proposal will be submitted for this task.

APPENDIX A

ROCKY GULCH CULVERT REPLACEMENT

DESCRIPTION OF WORK

These plans and specifications are for the culvert replacement for fish passage improvement of the existing culvert on Rocky Gulch at Old Arcata Road, Humboldt County, California. For proper functioning of the new culvert, it is important that the culvert be installed in accordance with the plans and specifications. No deviation from the plans and specifications are permitted except with the engineer's written approval. Any proposed alternatives and changes to various components must be reviewed and approved in writing by the engineer to determine if they comply with the design concept. It is important to note that these plans and specifications do not address the alignment, elevation, design or plans and specifications of the roadway surface or subgrade replacement, the relocation of crossing utilities, or the design, plans and specifications of the proposed overflow rock weir, overflow drainage ditch, and overflow culvert, all of which will be done by others.

GENERAL NOTES

None of the following specifications, notes, or plans shall preclude the owner or contractor from substitution of materials or practices necessary to complete the project in a timely and economical manner. Any substitution or bypass inspections without the explicit consent of the engineer become the responsibility of the owner or contractor. None of the following specifications, notes, or plans absolves the owner or contractor of the responsibility to procure any needed permits, clearances, and/or permissions. Where the specifications, notes, or plans are not consistent with local regulations, an engineer reconsideration of plans and specifications by the engineer is required prior to enactment of any changes.

This drawing does not accurately indicate any underground utility, easement, property line, or ownership information. Notify Underground Service Alert (800) 227-2600, three (3) working days prior to any excavation. The USA authorization number shall be kept at the job site.

Erosion control structures meeting applicable local standards and details/specifications contained in these plans shall be installed by the contractor. Erosion control structures shall contain and control erosion caused by silt deposits and provide for the safe discharge of siltation runoff from the project site into receiving water bodies. Suitable supplies for mitigating sediment impacts to receiving waterways shall be maintained at the project site by the contractor during construction.

If, during construction, archaeological remains are encountered, construction in the vicinity must be halted, and the State Office of Historic Preservation must be notified immediately.

All revisions to this plan must be revised by the engineer responsible for the plan preparation, and shall accurately be shown on revised plans.

Should it appear that the work to be done, or any matter relative thereto, is not sufficiently detailed or explained on these plans and attached specifications, the contractor shall contact the engineer responsible for plan preparation.

Culvert Installation

Culvert shall be 54' in length, 10'-8" width by 6'-11" height made of structural steel plate (SSP).

The culvert shall be installed in accordance with the plans and specifications, the Manufacturer's recommendations, the Standard Specifications - State of California, Department of Transportation, and Humboldt County requirements and specifications.

Channel Modifications

Rock slope protection (RSP) placement in all locations shall be per the Standard Specifications - State of California, Department of Transportation.

In-Channel Gravel

All in-channel gravel, except culvert backfill, required in the plans and specifications shall be 2" minus river run, and shall be well washed to remove all fines.

DISCLAIMER - UNAUTHORIZED CHANGE AND USES

The engineer responsible for preparation of these plans and specifications will not be responsible for, or liable for unauthorized changes to or uses of these plans. All changes to the plans must be in writing and must be approved by engineer responsible for preparation of these plans.

GENERAL SPECIFICATIONS

The work, requirements and provisions embraced herein shall be done in accordance with the Standard Specifications, State of California, Department of Transportation dated July 1992 or July 99, and the plans and general notes dated July 2001, insofar as the same may apply and in accordance with the Special Provisions, as outlined in later sections. All materials and work shall also conform to the latest adopted edition of the Uniform Building Code (UBC) and applicable Humboldt County requirements, ordinances, and specifications.

Construction Details

1. TRAFFIC CONTROL AND PUBLIC SAFETY. Traffic Control and Public Safety shall conform to the provisions in Section 7-1.03, "Public Convenience", Section 7-1.04, "Public Safety", Section 12, "Construction Area Traffic Control Devices", and Section 7, "Legal Relations and Responsibility" of the Standard Specifications.

2. WATER POLLUTION CONTROL. Water Pollution Control shall conform to the provisions in Section 7-1.01G, "Water Pollution" of the Standard Specifications and these Special Provisions.

a) The water pollution control shall conform to the requirements of the plans and specifications.
b) It will be the responsibility of the County of Humboldt and/or the contractor to obtain required permits relating to water pollution control.

3. CLEARING AND GRUBBING. Clearing and Grubbing shall conform to the provisions in Section 16, "Clearing and Grubbing" of the Standard Specifications.

4. CONSTRUCTION STAKING. Construction Staking shall conform to the provisions in Section 5-1.07, "Lines and Grades" of the Standard Specifications, and shall be set to conform to the lines and grades as shown on the plans.

5. EARTHWORK. Earthwork shall conform to the provisions in Section 19, "Earthwork" of the Standard Specifications, and the plans, and shall be set to conform to the lines and grades as shown on the plans.

a) Special attention is directed to the provisions in Section 19-3, "Structure Excavation and Backfill" of the Standard Specifications.
b) All in-channel gravel, except culvert backfill, required in the plans and specifications shall be 2" minus river run, and shall be well washed to remove all fines.

6. CULVERT DRAINAGE FACILITY. Culvert drainage facility shall conform to the provisions of Section 61, "Culvert and Drainage Pipe Joints", Section 62, "Alternative Culverts", and Section 67, "Structural Metal Plate Pipe" of the Standard Specifications, and these Special Provisions.

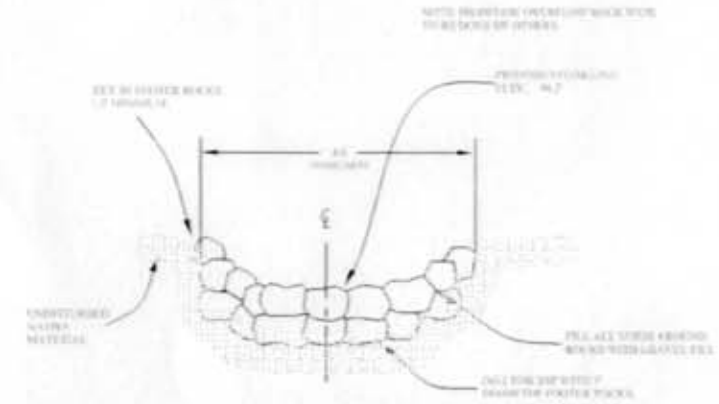
a) The culvert shall be 54' in length, 10'-8" width by 6'-11" height made of structural steel plate (SSP).
b) The culvert shall be installed in conformance with the lines and grades as shown on the plans.
c) Special attention is directed to the provisions in Section 19-3, "Structure Excavation and Backfill" of the Standard Specifications.

7. SLOPE PROTECTION. Slope protection shall conform to the provisions in Section 72, "Slope Protection" of the Standard Specifications, and these Special Provisions.

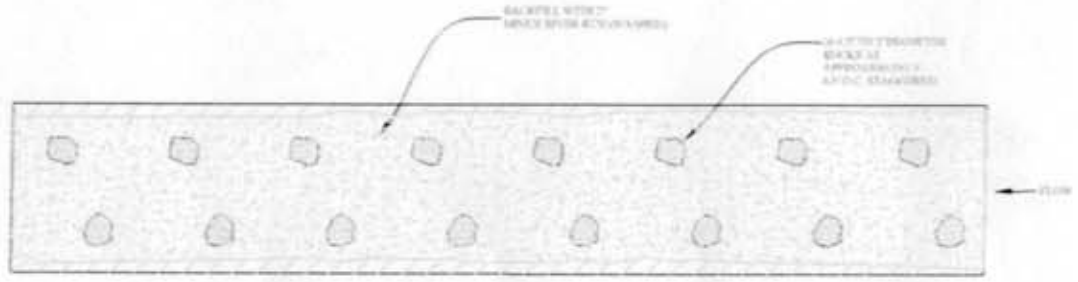
a) Rock slope protection (RSP) shall be of the size indicated on the plans.
b) All RSP shall be placed by Method A Placement, Section 72-2.03, "Placing" of the Standard Specifications. Minimum development length of all tension fabric shall be 12 inches.

LEGEND & ABBREVIATIONS

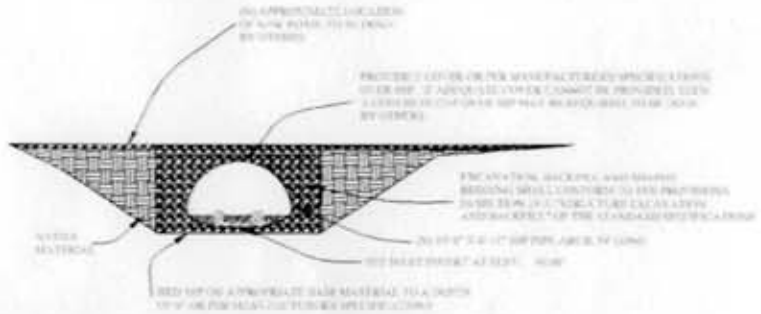
APPROX	APPROXIMATE
TYP	TYPICAL
CFS	CUBIC FEET PER SECOND
(E)	EXISTING
(N)	NEW
℄	CENTER LINE
CP	CONTROL POINT
	(E) 1' CONTOURS
	(N) DESIGN CONTOURS
	ACTIVE CHANNEL MARGINS
	NATIVE MATERIAL, UNDISTURBED
	BACKFILL, NATIVE MATERIAL
	2" MINUS RIVER RUN (WASHED)
	CULVERT BACKFILL AND BEDDING PER SECTION 19-3, "STRUCTURE EXCAVATION AND BACKFILL" OF THE STANDARD SPECIFICATIONS



PROPOSED HIGH FLOW OVERFLOW ROCK WEIR



CULVERT SIMULATED STREAM BED PLAN TYP



ROAD PROFILE AND CULVERT SECTION TYP 1

DESIGNED BY	JKA	6/01	REVISIONS
PREPARED BY	BS	7/01	

PREPARED FOR:
REDWOOD COMMUNITY ACTION AGENCY
904 G STREET
EUREKA, CA 95501

LANDSCAPE CONTRACTORS LICENSE # 516874

ROCKY GULCH CULVERT REPLACEMENT
OLD ARCATA ROAD, HUMBOLDT COUNTY, CALIFORNIA

GMA
GRAHAM MATTHEWS & ASSOCIATES
Hydrology · Geomorphology · Stream Restoration
P.O. Box 1316, Arcata, Ca. 95518-1316
(707) 826-8727 or (707) 822-9130 fax · gma@gma-arcata.com

SCALE VARIES

SHEET 4/4

Title: Rocky Gulch Culvert, Old Arcata Road

Summary Sheet

1. Contractor: .....Humboldt County Department of Public Works
2. Type of Contents:.....Public Agency
3. Street Address:.....1106 Second Street
4. City:.....Eureka
5. State:.....California
6. Zip Code: 95501
7. Contact Person: .....Donald C. Tuttle/Richard Stein
8. Telephone Number: .....(707) 445-7652/(707) 445-7741

9. Project Title:..... .Rocky Gulch Culvert Replacement
10. Funding Request:.....$72,450
11. Objective: Provide access to approximately 1.75 miles of potential anadromous fish habitat. Replace clogged, undersized culverts with a structure that will not be a barrier to adult or juvenile salmonids.

12. Species Benefited:.....Coho Salmon, Steelhead, Coastal Cutthroat Trout
13. Work Schedule:.....Summer/Fall 2001
14. County:.....Humboldt
15. Stream: .....Rocky Gulch
16. Tributary to:.....Humboldt Bay
17. Major Drainage System: ..... Humboldt Bay
18. Assembly District: 1
19. Senate District: 2
20. Past Contractor (Contracted with DFG in the past for fisheries restoration work):.....Yes
21. Federal Taxpayer ID#:.....53-019-7006
22. Project Site Falls Within the Coastal Zone? .....Yes
23. Project Site Falls Within Klamath River Basin?.....No
24. Project Site Falls Within Trinity River Basin?.....No
25. Project Type:.....HB

Title: Rocky Gulch Culvert Replacement

Project Proposal

Background

This site was identified as an instream barrier during the SB-271 funded inventory of Humboldt County's road system. California Department of Fish & Game files contain reports of an annual coho salmon run prior to 1956. California Department of Fish & Game surveys during the 1960s noted "poor" habitat conditions due to excessive siltation and slash dumped in channel. Despite apparent long term land-use abuses, the watershed has continued to provide habitat for anadromous salmonids as noted by a 1999 survey conducted by Simpson Timber Company which revealed water temperatures in the mid 50sF and the presence of juvenile salmonids. Replacement of the existing undersized culverts will improve access for adult and juvenile salmonids by removing the velocity barrier they represent.

Proposed Land Use

Surrounding area is recovering from past logging. Presumably, it will be logged in the future but with greater care and concern for anadromous fish habitat.

Location

The culverts are located on Old Arcata Road, 2,100' south of Indianola Road and are shown on the Arcata South 7.5' USGS Quadrangle Map in Section 16, Township 5N, Range 1E.

Objectives

Goal of the project is to replace the two undersized, easily plugged culverts with a structure that will pass flood flows and debris and provide access for adult and juvenile salmonids to upstream spawning and rearing habitat.

Project Description

Replace existing 3'0" ϕ concrete culverts with a 16'-1" x 5'-3" x 50' bottomless aluminum box culvert. Box culvert will be constructed on concrete grade beams and will include concrete head walls.

Permits

California Department of Fish & Game 1601
Corps of Engineers 404 Permit
Regional Water Quality Control Board Waiver of Certification
State Coastal Development Permit
CEQA Document

Schedule

Summer/Fall 2001

Agency Review

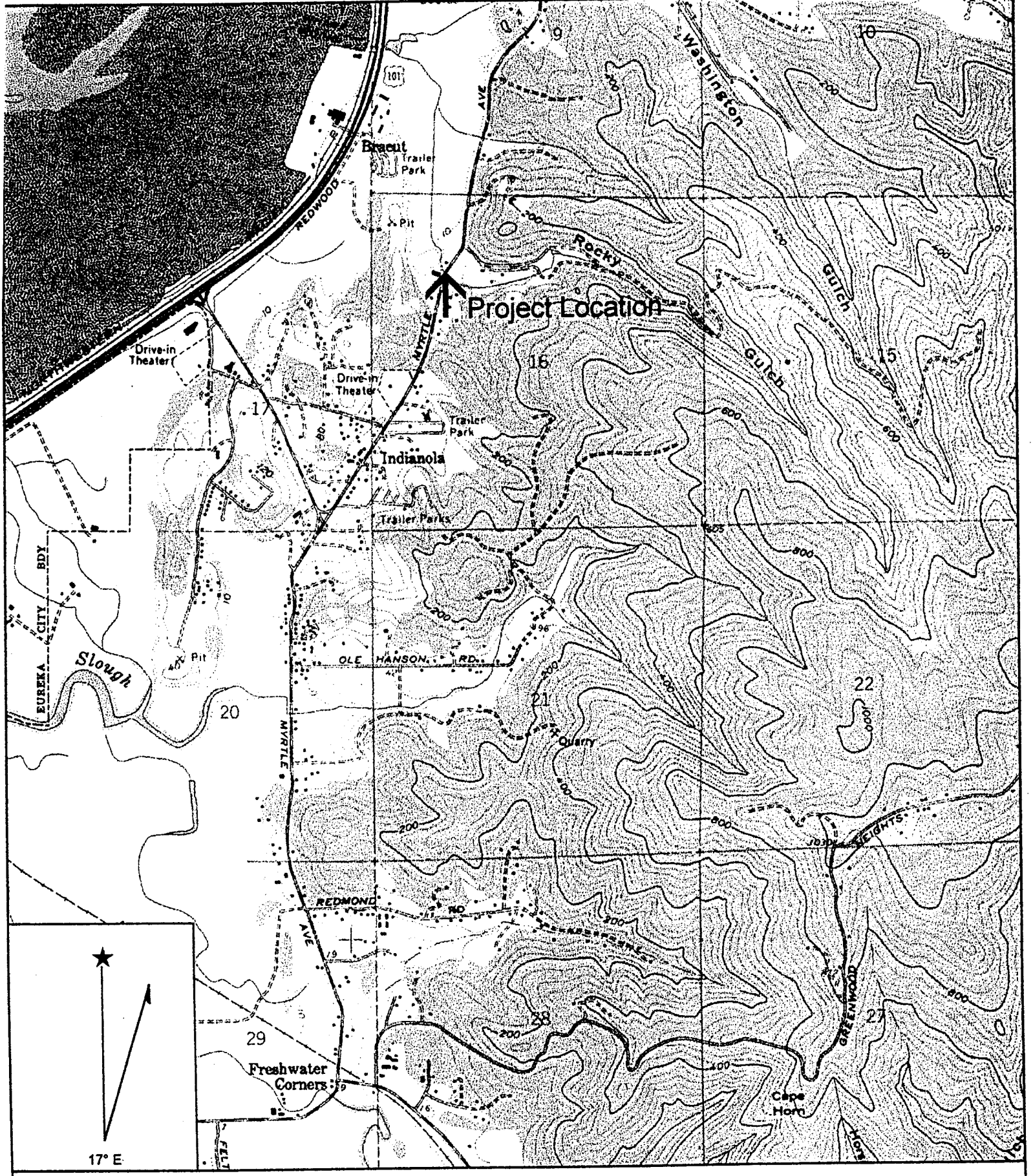
Prior to construction the project will be reviewed by:

Fish & Game
Corps of Engineers
National Marine Fisheries Service
Regional Water Quality Control Board

ROCKY GULCH, OLD ARCATA ROAD , HUMBOLDT BAY
CULVERT REPLACEMENT
ESTIMATED BUDGET

	Number of Hours	Hourly Rate	Amount Requested	Amount of Cost Share	Project Total
PERSONNEL COSTS					
Hired Labor					
Crew Foreman	60	31.50	$1,512.00	$378.00	$1,890.00
Equipment Operator	40	26.43	$845.76	$211.44	$1,057.20
Carpenter	16	22.02	$281.86	$70.46	$352.32
Cement Mason	8	21.75	$139.20	$34.80	$174.00
Iron Worker	4	23.68	$75.78	$18.94	$94.72
Truck Driver	32	20.91	$535.30	$133.82	$669.12
Laborer	120	20.33	$1,951.68	$487.92	$2,439.60
Contractor's Overhead 15%			$801.24	$200.31	$1,001.54
Fringe Benefits @ 28.16%			$1,504.19	$376.05	$1,880.23
Labor Surcharge 33%			$1,762.72	$440.68	$2,203.40
TOTAL PERSONNEL COSTS			$9,409.71	$2,352.43	$11,762.13
OPERATING EXPENSES					
Construction materials (16'-1"x5'-3"x50' bottomless aluminum box culvert - $40,000, concrete grade beams & headwalls - 10 cy@ $100/cy, rebar. - 200 @ $1,structure backfill - 75 cy @ $15/cy, aggregate base - 35cy @ $20/cy, asphalt concrete surfacing - 20 ton @ $40/ton)			$42,325.00	$1,500.00	$43,825.00
Construction supplies			$1,000.00	$0.00	$1,000.00
Tools and instruments			$1,000.00	$0.00	$1,000.00
Seeds, plants and fertilizer			$1,000.00	$0.00	$1,000.00
Equipment lease/rental					
excavator - 40 hrs @ $90.00			$3,600.00	$0.00	$3,600.00
lowboy - 2 hrs @ $35.00			$70.00	$0.00	$70.00
2 yd loader - 40 hrs @ $65.98			$2,639.20	$0.00	$2,639.20
grader - 20 hrs @ $42.53			$0.00	$850.60	$850.60
drum roller - 20 hrs @ $18.71			$0.00	$374.20	$374.20
10 yd dump - 32 hrs @ $23.70			$0.00	$758.40	$758.40
Force Account Markup 15%			$7,745.13	$522.48	$8,267.61
Other					
401 Permit			$500.00	$0.00	$500.00
RWQCB Permit			$662.00	$0.00	$662.00
F & G Permit			$1,000.00	$0.00	$1,000.00
Liability Insurance			$1,500.00	$0.00	$1,500.00
Workers Compensation Insurance					
TOTAL OPERATING EXPENSES			$63,041.33	$4,005.68	$67,047.01
TOTAL ESTIMATED BUDGET			$72,451.04	$6,358.11	$78,809.14

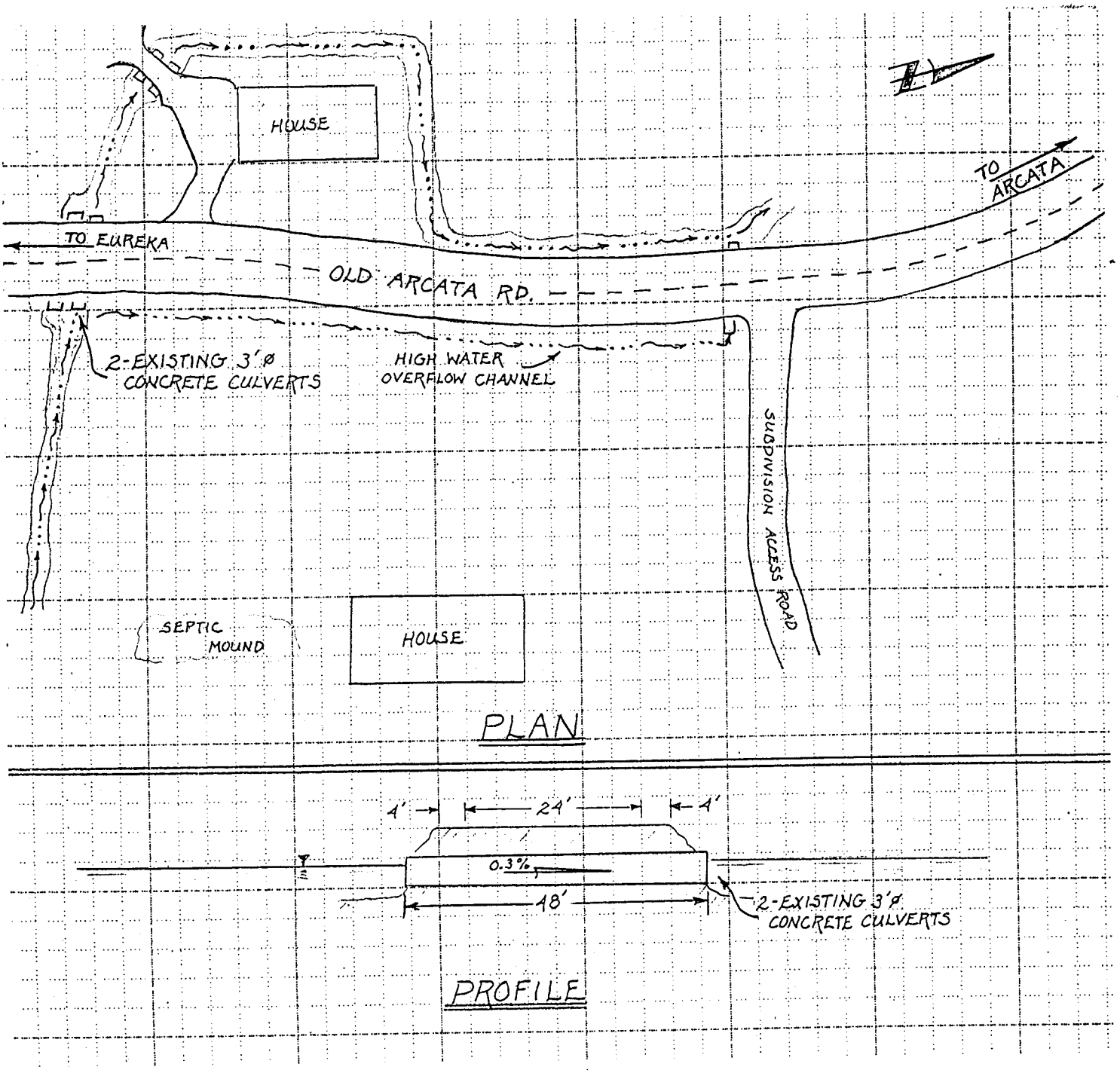
PERCENT COST SHARE: 8.07%



Name: ARCATA SOUTH
Date: 2/17/100
Scale: 1 inch equals 2000 feet

Location: 040° 48' 26.5" N 124° 04' 25.3" W
Caption: Arcata South Quad: 7.5 Minute Series

Copyright (C) 1997, Maptech, Inc.



ROCKY GULCH SITE PLAN & PROFILE

PURPOSE: REPLACEMENT OF EXISTING BARRIER CULVERT WITH AN ENHANCED PASSAGE STRUCTURE

LOCATION: OLD ARCATA ROAD (3K300), BAYSIDE

TRIBUTARY BASIN: HUMBOLDT BAY

SHEET NO. 6 of 7

DATED: 2/25/00

INLET

OUTLET

ROCKY GULCH SITE PHOTOGRAPHS

PURPOSE: REPLACEMENT OF EXISTING BARRIER CULVERT WITH AN ENHANCED PASSAGE STRUCTURE

LOCATION: OLD ARCATA ROAD (3K300), BAYSIDE

TRIBUTARY BASIN: HUMBOLDT BAY

DATED: 2/25/00

SHEET NO. 7 of 7

APPENDIX B

WINZLER & KELLY
CONSULTING ENGINEERS

Ref: 02-1686-01001

May 21, 2002

Darren Mierau
McBain and Trush
P.O. Box 663
Arcata, CA 95521

Re: Preliminary Cost Estimates for Alternative Stream Crossing at Rocky Gulch

Dear Darren:

As per our agreement I am providing you with a preliminary cost estimate and alternatives comparison for replacing the existing culvert stream crossing at Rocky Gulch. Based on our discussions and site visit, three replacement alternatives are evaluated here; 1) Flat car or steel bridge, 2) Open bottom arch culvert and 3) Embedded round culvert.

An itemized construction cost estimate is attached for each alternative. This estimated cost includes engineering and permitting for dewatering and fish removal, demolishing the existing CMP and concrete abutments, excavating the new crossing, preparation of the surface for the new structure, construction of footings or abutments, installation and assembly of the new structure, backfilling, compaction and preparation of the road base. These numbers represent a budgetary cost estimate and would need to be revised after the final design is completed.

Background
The private driveway on Rocky Creek Road crosses Rocky Gulch via a 4' diameter culvert located approximately 7600' from the confluence with Humboldt Bay. The driveway will continue to provide access to existing and future houses at this location. The existing culvert is a corrugated metal pipe (CMP) that is 4' in diameter and 60' in length. The current condition of the culvert has minimal corrosion and is flattened at the centerline of the road. The CMP is undersized and the outlet is perched 4' above the plunge pool. It is a complete barrier to migrating salmon at all life stages. The land at the crossing and upstream was used as a lumber mill. There is evidence of levee construction and channel encroachment along the edge of the mill site.

Design Parameters
The drainage area is 1.05 square miles and the 100 year flow was estimated by the Humboldt County Department of Public Works to be 344, 378, and 950 cfs using three different methods. For this analysis, I assumed that the Q_{100} was 350 cfs. From field measurements taken on May 3, 2002, the active channel width is 7 – 9', and the average upstream and downstream channel slope

is approximately 1.5%. For this preliminary analysis, I assumed that the new channel would be controlled by the outlet pool, tail-out elevation, and would have a 2% slope.

1. Bridge Alternative

Replacement of the culvert with a bridge spanning the stream would allow for long-term channel adjustment. According to NMFS and DFG, the bridge option is the most preferred alternative for fish passage (second to complete realignment of the road to avoid the crossing). The channel below the bridge retains its natural state and is the best ecological alternative since it will allow for natural flow of sediment, debris, floods and is essentially transparent to fish.

Based on a 9' active channel width, a maximum of 1.5 to 1 (h:v) side slopes and a ten foot setback to each of the bridge footings, the required span would be 60 feet. Both bridge options, detailed below, would require 2 concrete block footings on a gravel pad. Setting these back ten feet from the top of the bank ensures stability and minimizes abutment construction. The abutments are preformed and placed in an excavated hole that is backfilled with compacted with aggregate base. A bridge could be delivered in two pieces, offloaded using a crane, or two front-end loaders or two excavators, and assembled on site. The bridge is then lowered onto the abutments and bolted into place. The deck would be flush with the existing road level and the surface treated with wood planks or gravel road fill.

The new channel bank would be lined with rock slope protection that would span the channel. The RSP and newly exposed banks would be planted with native vegetation and stabilized using standard bioengineering techniques.

Two bridge manufactures were contacted for pricing a new steel bridge and a recycled flatcar bridge. While the flatcar bridge was more expensive, it is a recycled product and is provided by a local manufacturer. Both manufacturers can provide custom railing configurations. The standard single lane width of a flatcar bridge is 17' (two cars side by side) and 14' for the new steel bridge.

Design considerations include alignment of the bridge to accommodate the curved and steep driveways.

Preliminary Estimates: Steel (Flat Car) Bridge
Span = 60' Width = 14 (17)' Total estimated cost: $130,000

2. Open Bottom Arch Alternative

The open bottom arch represents the stream bed simulation option for fish passage. They have been used successfully in many areas, especially when a bridge is not feasible or practical. Arches are made of concrete or galvanized steel that is attached to a concrete strip footing that sits below the anticipated scour level.

Construction consists of over excavating the crossing, forming and pouring the strip footings, backfilling the channel with engineered gravel, assembling the multiplate arched culvert, and backfilling and compacting to the desired road elevation.

In order to estimate the size of an arch culvert, I assumed that the bankfull channel width is 11'. Road prism side slopes must be 1.5 to 1 (h:v) or less, thereby requiring a 60' long culvert. The length of the culvert (and the cost) can be decreased if the width of the road is decreased. The road is currently over widened and grown over.

A significant cost item in this type of crossing is the construction of the concrete footings. Design considerations include scour analysis for proper placement of the footings to ensure that they are not undermined by future channel adjustments.

Preliminary Estimates: Open Bottom Arch
Span = 12' Rise = 7" Length = 60' Total estimated cost: $140,000

3. Embedded Culvert Alternative
Embedded or sunken culverts represent the streambed simulation option, where the culvert is sized wider than the channel, sunken at the inlet and outlet and filled with stream bed material. The intent is that sediment transport, fish passage and flood and debris conveyance function as they would in the natural channel. Use of sunken culverts is increasing, largely because of the ease of installation and lower costs.

The Washington Fish and Wildlife and the Oregon Department of Forestry guidelines were used for preliminary sizing of the embedded round culvert. These guidelines call for a culvert diameter that is 1.5 times the active channel width that is countersunk by 40%. Using 7' as the active channel, the required diameter was calculated to be 11' and with an embedment of 4.4'. Based on a road prism that is sloped at a maximum of 1.5 to 1 (h:v), the culvert would be approximately 60' in length with 6'of cover. The length of the culvert (and the cost) can be decreased as previously discussed

Design considerations include a thorough understanding of the sediment transport characteristics of the channel. If the downstream channel headcuts toward the culvert or if the velocities in the culvert scour the sediment out, a perched culvert will likely result.

Preliminary Estimates: Embedded Culvert
Diameter = 11' Length = 60' Total estimated cost: $82,000

Other Design and Construction Considerations
The cost estimate and analysis presented here does not consider the abandoned Humboldt Crossing that is located 40' upstream of the subject culvert. Much of the sediment that is stored

in the upstream channel has been deposited as a result of the subject culvert and this crossing. When the culvert is removed and the channel is lowered to accommodate the natural channel slope the upstream channel will begin to regrade. This headcut may end up perching the crossing or possibly eroding out from under it. The sediment released from the upstream channel could be controlled through the use of grade control structures such as weirs, or released and allowed to adjust naturally and fill in the downstream plunge pool that was created by the existing culvert. Further analysis and consultation with permitting agencies should address this issue.

Please feel free to call with any questions about this report or if you need further information.

Sincerely,
WINZLER & KELLY

Antonio Llanos
Project Engineer

lcf

Enclosure: Cost estimates, calculations with schematic drawings

Rocky Gulch Fish Passage Barrier Removal Project
McBain & Trush

W&K Job #: 02168601

Date 5/9/02

Estimated Construction Costs for Culvert Removal and Bridge Replacement

Type: Big R / Skip Gibbs Bridge (17' x 60')

Item	Description	Qty	Unit	Unit Cost	Total Cost
1	Mob/Demob Cost	1	LS	$ 2,000.00	$ 2,000
2	Clearing/Grubbing	1	LS	$ 1,000.00	$ 1,000
3	Water Diversion	1	LS	$ 4,800.00	$ 4,800
4	Fish Removal	1	LS	$ 2,000.00	$ 2,000
5	Excavation	1	LS	$ 2,500.00	$ 2,500
6	Demo Existing CMP Culvert	1	LS	$ 5,000.00	$ 5,000
7	Haul off Excavation Materials	1	LS	$ 2,000.00	$ 2,000
8	Dump Fees for Misc Debris	1	LS	$ 800.00	$ 800
9	RSP Placement/Bank Stabilization	200	TON	$ 50.00	$ 10,000
10	Washed Gravel in Channel	35	TON	$ 40.00	$ 1,400
11	Class 2 Base Prep for Bridge Footings	2	EA	$ 1,000.00	$ 2,000
12	Concrete Bridge Footings	2	EA	$ 2,500.00	$ 5,000
13	Replacement Bridge delivered	1	LS	$ 54,000.00	$ 54,000
14	Install Flatcar / Bridge	1	LS	$ 2,450.00	$ 2,450
15	Rebuild Roadway Approaches	80	TON	$ 40.00	$ 3,200
16	Redwood mulch, cleanup	1	LS	$ 500.00	$ 500
17					
Subtotal					$ 98,650
	Engineering and Design				$ 11,000
	Estimating Contingency			20%	$ 19,730
				Total	**$ 129,380**

Notes: Does not include removal of abandoned Humboldt Crossing

Skip Gibbs Bridge (60' x 17')	$ 54,000
Big R Bridge (60' x 14')	$ 49,000

Rocky Gulch Fish Passage Barrier Removal Project
McBain & Trush

W&K Job #: 02168601

Date 5/9/02

Estimated Construction Costs for Culvert Removal and Replacement with Open bottom Arch

Type: Open Bottom Arch (12' x 7' x 60')

Item	Description	Qty	Unit	Unit Cost	Total Cost
1	Mob/Demob Cost	1	LS	$ 2,000.00	$ 2,000
2	Clearing/Grubbing	1	LS	$ 1,000.00	$ 1,000
3	Water Diversion	1	LS	$ 4,800.00	$ 4,800
4	Fish Removal	1	LS	$ 2,000.00	$ 2,000
5	Excavation	1	LS	$ 10,000.00	$ 10,000
6	Demo Existing CMP Culvert	1	LS	$ 5,000.00	$ 5,000
7	Haul off Excavation Materials	1	LS	$ 2,000.00	$ 2,000
8	Dump Fees for Misc Debris	1	LS	$ 800.00	$ 800
9	RSP Placement/Bank Stabilization	100	TON	$ 50.00	$ 5,000
10	Washed Gravel in Channel	32.4	TON	$ 40.00	$ 1,296
11	Class 2 Base Prep for Footings and backfill	60	TON	$ 40.00	$ 2,400
12	Concrete Footings	30	CY	$ 350.00	$ 10,500
13	Replacement Arch Culvert delivered	1	LS	$ 20,000.00	$ 20,000
14	Install and assemble Arch	1	LS	$ 15,000.00	$ 15,000
15	Rebuild Roadway Approaches	80	TON	$ 40.00	$ 3,200
16	Backfill and compact road prism	1	LS	$ 12,000.00	$ 12,000
17	Redwood mulch, cleanup	1	LS	$ 500.00	$ 500

Subtotal		$	97,496
	Engineering and Design	$	14,000
	Geotechnical Study	$	6,000
	Estimating Contingency 20%	$	19,499
	Total	**$**	**136,995**

Notes: Does not include removal of abandoned Humboldt Crossing

Rocky Gulch Fish Passage Barrier Removal Project
McBain & Trush

W&K Job #: 02168601

Date 5/9/02

Estimated Construction Costs for Culvert Removal and Replacement with Embedded Culvert

Type: Embedded Culvert Installed Flat (11' x 60')

Item	Description	Qty	Unit	Unit Cost	Total Cost
1	Mob/Demob Cost	1	LS	$ 2,000.00	$ 2,000
2	Clearing/Grubbing	1	LS	$ 1,000.00	$ 1,000
3	Water Diversion	1	LS	$ 4,800.00	$ 4,800
4	Fish Removal	1	LS	$ 2,000.00	$ 2,000
5	Excavation	1	LS	$ 5,000.00	$ 5,000
6	Demo Existing CMP Culvert	1	LS	$ 5,000.00	$ 5,000
7	Haul off Excavation Materials	1	LS	$ 2,000.00	$ 2,000
8	Dump Fees for Misc Debris	1	LS	$ 800.00	$ 800
9	RSP Placement/Bank Stabilization	80	TON	$ 50.00	$ 4,000
10	Washed Gravel in Channel	32.4	TON	$ 40.00	$ 1,296
11	Class 2 Base Bedding for Culvert	20	TON	$ 40.00	$ 800
12	Replacement Culvert delivered	60	LF	$ 304.00	$ 18,240
13	Install Culvert	1	LS	$ 2,450.00	$ 2,450
14	Rebuild Roadway Approaches	80	TON	$ 40.00	$ 3,200
15	Backfill and compact road prism	1	LS	$ 6,000.00	$ 6,000
16	Redwood mulch, cleanup	1	LS	$ 500.00	$ 500
Subtotal					$ 59,086
	Engineering and Design				$ 11,000
	Estimating Contingency			20%	$ 11,817
				Total	**$ 81,903**

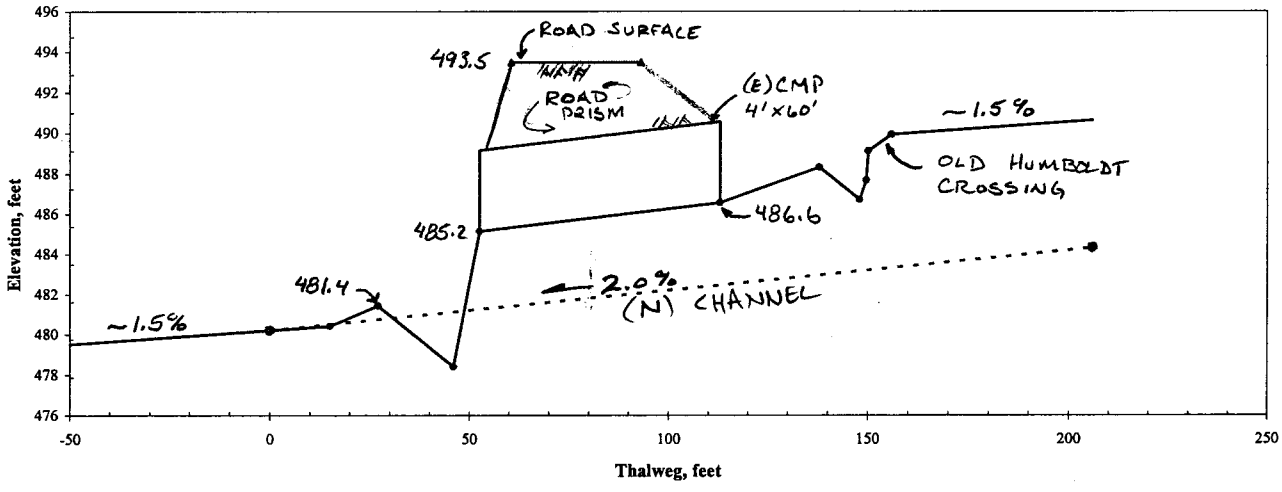
Notes: Does not include removal of abandoned Humboldt Crossing

WINZLER & KELLY
CONSULTING ENGINEERS
633 Third Street, Eureka, CA 95501-0417
(707) 443-8326 / FAX (707) 444-8330

By TL Date 5/13/02 Client McBAIN & TRUSH Sheet No. 1 of 3

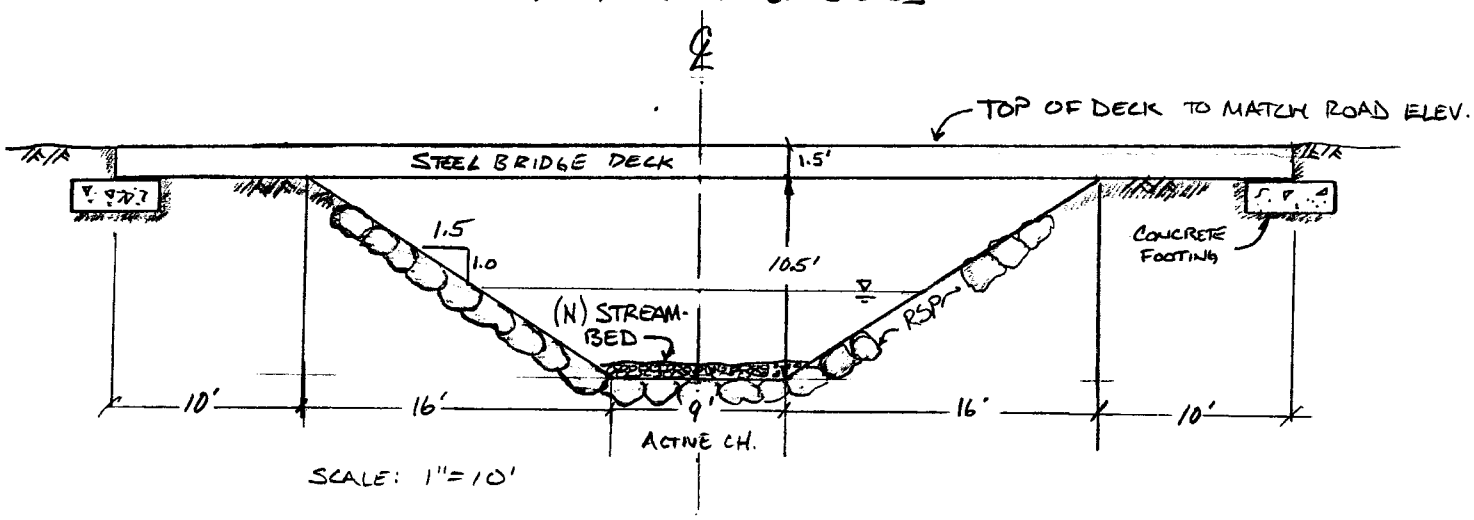
Subject Rocky GULCH CULVERT / BRIDGE REPLACEMENT Job No. 02168601

PROFILE:



SECTION:

ASSUME: TAIL OUT IS NEW CHANNEL ELEVATION (APPROX 2% SLOPE)
ACTIVE CHANNEL WIDTH = 9.0'
BIG R STEEL BRIDGE FOR DIMENSIONS



NEW BRIDGE DECK.

WIDTH = 14(17')
SPAN = 60'

WINZLER & KELLY
CONSULTING ENGINEERS
633 Third Street, Eureka, CA 95501-0417
(707) 443-8326 / FAX (707) 444-8330

By TL Date 5/15/02 Client McB;T Sheet No. 2 of 3

Subject EMBEDDED CULVERT Job No. 02168601

EMBEDDED / SUNKEN CULVERTS.

DESIGN ASSUMPTIONS:

1. CHANNEL SLOPE < 2.5% (1.5%)
2. Q_{BF} = 350 cfs
3. D.A = 1.05 mi^2
4. ROAD PRISM SIDE SLOPE 1.5:1
5. CULVERT SET AT 0% SLOPE
6. ACTIVE CHANEL APPROX 7'
7. COUNTER SINK 40% OF DIAM OR 2' (WHICHEVER IS GREATER) FOR ROUND CULVERT
8. CULVERT DIAM = 1.5 × A.C. (DFG)

CULVERT DIAM: 7' × 1.5 = 10.5' SAY 11.0'

COUNTER SINK: 11.0 × 0.4 = 4.4'

EFFECTIVE CROSS SECTIONAL AREA: $(5.5^2\pi) \times (1-0.4)$ = 57.0 sqft

FLOW CAPACITY: APPROX 450 cfs

HEIGHT OF COVER:
STREAM BED = 481.4
− EMBEDDMENT = 4.4
= BOTTOM OF CV = 477.0
+ HEIGHT OF CV = 11.0
TOP OF CV = 488.0
− ROAD SURFACE = 493.5
COVER = 5.5'

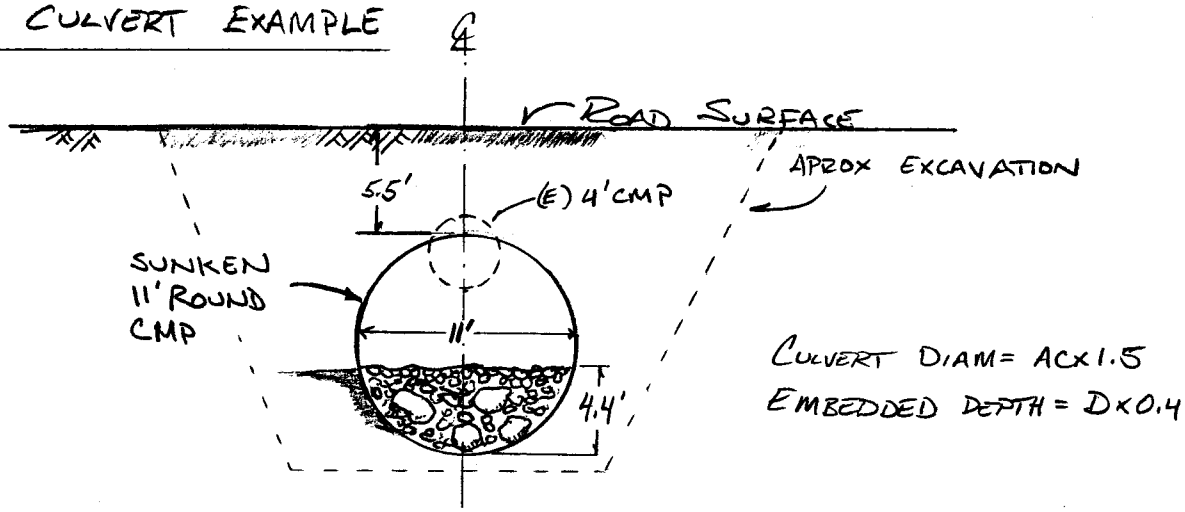
LENGTH: 60'

WINZLER & KELLY
CONSULTING ENGINEERS
633 Third Street, Eureka, CA 95501-0417
(707) 443-8326 / FAX (707) 444-8330

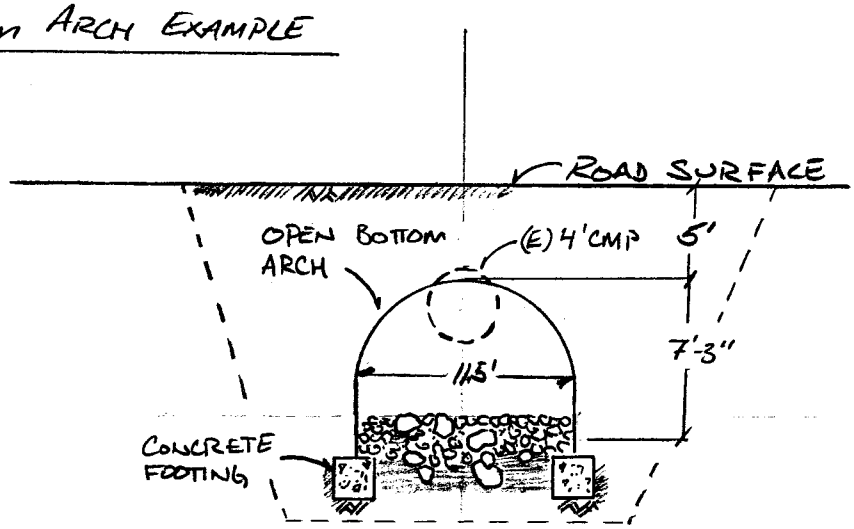
By TL Date 5/17/02 Client McBain & Trush Sheet No. 3 of 3

Subject Culvert Section Example. Job No. 02168601

EMBEDDED CULVERT EXAMPLE



OPEN BOTTOM ARCH EXAMPLE



HUMBOLDT COUNTY DEPARTMENT OF PUBLIC WORKS
ENGINEERING DIVISION
1106 SECOND STREET • EUREKA, CA 95501
PHONE (707) 445-7377 FAX (707) 445-7409

DATE	PROJ. NO.	MADE BY	CHK'D BY	PAGE
4/3/00	Rocky Gulch	Chris Whitworth		

Rocky Gulch Hydrology

Watershed Area - 675 acres
1.055 mi (1.125 mi)

Length - 3.08 mi

Δ Elevation - 1180

Annual Precip. - 39.76 in.

Waananen and Crippen

$$Q_{100} = 9.23\, A^{0.87} P^{0.97}$$

$$Q_{100} = 9.23(1.055)^{0.87}(39.76)^{0.97}$$

$$Q_{100} = 344 \text{ cfs}$$

Rational Method

$$t_c = 60\left[11.9 \frac{L^3}{H}\right]^{0.385}$$

$$t_c = 60\left[11.9 \frac{(3.08)^3}{1180}\right]^{0.385}$$

$$= 37.5 \text{ min}$$

From Eureka IDF $i \approx 1.6$ in/hr.

$$C = 0.35$$

$$Q = ciA = 0.35(1.6)(675) = 378 \text{ cfs}$$

Log Pearson Type III - Watershed Ratio w/ Jacoby Creek

Jacoby Creek $Q_{100} = 3440$ cfs
Area = 5.8 mi

$$\frac{1.6}{5.8} = \frac{Q}{3440} \rightarrow Q_{100} = 950 \text{ cfs}$$

APPENDIX C

WATERSHED OVERVIEW WORK SHEET

Date ____/____/____ Investigator DARREN MIERAU
Stream Name ROCKY GULCH PNMCD —
Tributary to NORTH HUMBOLDT BAY Tributary to
Tributary to Tributary to
County HUMBOLDT CO. USGS Quad

Location T 5N R 1E S 16 Latitude 45.821°N Longitude 124.076°W

Access Via HWY 101 / OLD ARCATA RD.

Hydrologic Boundary Delineation NORTH COAST (N.C.)

Aerial Photos (Source) HUMBOLDT COUNTY DEPT OF ENVIRONMENTAL RESOURCES.
WAC CORP. / EUGENE OR. 97402

Stream Order 2° Total Length 2.65 miles

Drainage Area 1.125 mi² above OAR sq. mi. Summer Base Flow 0.31 * cfs

Elevations Mouth 16 ft @ OAR feet Headwaters 1330 ft on SPRING MT feet

Lakes in Watershed Number NONE Surface Area ~ sq. mi.

Fish Species (Data Source) ONCORHYNCHUS CLARKI (CUTTHROAT TROUT),
" KISUTCH (COHO SALMON) (HISTORICALLY),
" MYKISS (STEELHEAD)
GASTEROSTEUS ACULEATUS (THREE-SPINED STICKLEBACK)

Endangered/ Threatened/ Sensitive Species (Data Source)
CENTRAL CA COAST ESU - COHO SALMON: FEDERAL ESA THREATENED; OCT 31, 1996; NOAA FISHERIES: NMFS
N°. CA. ESU STEELHEAD: FEDERAL ESA THREATENED JUNE 7, 2000; " " "
Endemic Stocks (Data Source)

Fishery Management Concept
Cold Water: Natural Production ✓
Mixed Production
Anadromous: Natural Production ✓
Mixed Production
Warm Water:
Other:

Stream Flow Data (Source) NO DIRECT HISTORICAL RECORDS
HISTORICAL STREAMFLOW DATA CONVERTED FROM LITTLE RIVER (USGS #11-481200) (D.A.=49.4 mi²)
DIRECT ON-STREAM STREAMFLOW MSMT BEGAN SEPT. 1 2001 (D. MIERAU)
Water Quality Data (Source) NONE TO-DATE (2 tests)

Ownerships in Stream Mi. Federal ____ State ____ Private 100%
Additional Information ENTIRE WATERSHED IS PRIVATELY OWNED

Major Land Uses in the Watershed: 1A, 1B, 3B, 4A, 4B
Additional Information

Comments * Stream flow data based on conversion of Little River w/ Trinidad USGS data, based on drainage area difference.